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16. Abstract

Using an expert panel, we conducted a prospective study of all deaths due to injury occurring in 24 non-MSA counties to determine the preventable death rate (PDR) and to identify the frequency and nature of inappropriate medical care associated with those deaths. Panel review was conducted using a structured implicit review format. A second panel was also convened to determine the reliability of the review process.

One hundred fifty-five deaths were analyzed. Ninety patients were pronounced dead at the scene and 65 patients were transported to a hospital. Twenty patients were identified as having definitely preventable or possibly preventable deaths for an overall PDR of 12.90%. For patients transported to a hospital the PDR was 27.69%. Motor vehicle crashes were the most common mechanism of injury overall and also among preventable deaths. Overall, the most frequent physiologic cause of death was central nervous system injury. Among preventable deaths, death from hemorrhage was most frequent.

There were a total of 43 episodes of inappropriate care with 31 episodes occurring among preventable deaths. Among episodes of inappropriate care associated with preventable death, 12 occurred in the ED phase, 12 occurred in the in-hospital phase and 7 in the prehospital phase. Among preventable deaths the three most frequent types of inappropriate care were delays in treatment and/or evaluation (14), airway/ventilation management (7) and fluid/blood replacement (5).

The second panel reviewed 75 cases. Inter-Panel agreement, as measured by Kappa was good (0.600).

Only a relatively small percentage of rural trauma fatalities could have been saved by more appropriate or timely medical care. Current efforts to reduce this percentage should be primarily directed at care in the ED and in-hospital care and secondarily at prehospital care. Additional studies are warranted to determine the cause for inappropriate care being rendered. Further studies should also evaluate the manner by which resources need to be distributed between primary injury prevention and acute trauma care in order to most efficiently decrease rural trauma mortality.

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1.0 The Problem Identification Process

Trauma is the leading cause of death for persons 34 years or younger. It is also the largest contributor to years of potential life lost [Ntnl Acad Sci, Ntnl Rsrch Cncl, 1986] [Ntnl Acad Press, 1985]. Motor vehicle crashes (MVC) account for the largest proportion of these deaths. For most unintentional injuries, except falls, deaths rates are higher in rural areas. In particular, studies of geographic variation in death rates due to motor vehicle accidents have demonstrated a disproportionately high death rate in areas of low population density [Waller, Curran, Noyes, 1964] [Waller, Garner, Lawrence, 1966] [Baker, 1987] [Bentham, 1986] [Brodsky, 1983] [Maio, Green, Becker, 1992].

Drivers in Michigan involved in rural MVC's are twice as likely to die as their non-rural counterparts [Maio, Green, Becker, 1992]. In 1993, the Michigan death rate from injury was 53/100,000 population, slightly lower than the 1992 national injury death rate of 56/100,000 population. Although several studies in the United States and one study from Great Britain have concluded that regional variation in trauma mortality could be due to variation in the quality of medical care [Baker, 1987] [Bentham, 1986] [Brodsky, 1983] [Kearney, Stallones, Swartz, 1990] [Mueller, Rivara, Bergman, 1988] [Waller, Curran, Noyes, 1964] [Waller, 1969], three studies from Michigan have been unable to find a significant relationship between the level of rural medical care and increased rural MVC mortality [Chen, Maio, Green, 1995] [Maio, Burney, Lazzara, 1990] [Maio, Green, Becker, 1992]. These studies in Michigan, however, have been ecological in nature and/or did not determine the frequency, nature and appropriateness of acute trauma care.

Other investigators have studied rural trauma care, without comparison to non-rural areas, and have noted deficiencies in access to care and timely evaluation and treatment

[Houtchens, 1977] [Perrine, Waller, Harris, 1971] [Certo, Rodgers, Pilcher, 1983]. Julian Waller discussed the problems and prospects of rural emergency care and outlined the steps taken in Vermont to develop effective, high quality pre-hospital care systems [Waller, Garner, Lawrence, 1966] [Waller, 1969]. He also concluded that urban-oriented methods failed to solve rural emergency care problems. Except for a recently completed study from Montana [DTNH22-90-C-05016, DOT/NHTSA/EMS Div., 1992], studies that have evaluated rural trauma care have not been population based, contained little specific information regarding the appropriateness of medical treatment during all phases of trauma system care and, have not used an outcome measure specifically related to quality of care.

1.1 Preventable Death Rate

The preventable death rate (PDR) is a trauma care quality outcome measure that has been widely used for global evaluation of the quality of trauma system care in a hospital or region [Cales, 1984] [Campbell, Watkins, Kreis, 1989] [Cayten, Stahl, Agarwal, 1991] [Certo, Rogers, Pilcher, 1983] [Kreis, Plasencia, Augenstein, 1986] [Lowe, Gateley, Goss, 1983] [Rivara, Maier, Mueller, 1989] [West, 1982]. The PDR is defined as the proportion of trauma patients that die which may have been salvaged had optimal trauma care been provided. When preventable deaths are identified, the components of the trauma care system in that area can be examined to determine possible deficiencies contributing to those deaths. This examination may lead to changes in trauma care protocols that could bring about a decrease in the incidence of preventable mortality. Investigators have therefore used a decrease in the PDR as evidence that changes in system or individual performance protocols have been effective [West, Cales, Gassangia, 1983] [West, Trunkey, Lim, 1979].

Using methodology similar to that used by investigators in the Montana study, we conducted a population based study in Michigan to: 1) Determine the trauma preventable death rate (PDR) in rural Michigan; 2) Determine the frequency and nature of inappropriate medical care among preventable trauma deaths; 3) Determine the reliability of a new, structured panel review process used in this study; 4) Make recommendations for improving rural trauma care; and 5) Make recommendations for improving the evaluation of rural trauma care.

2.0 The Rationale for the Selection of this Process

2.1 Selecting the Mechanisms of Injury to be Studied

The mechanisms of injury, based on ICD-9-CM external cause of injury codes (E codes), that were included were specified by NHTSA in the request for proposal (RFP) that was the funding source for this study. These included E codes 800-807, 810-829, 830-838, 840-844, 846-848, 880-888, 916-923, 955-959, and 965-969, but excluded injuries due to the following mechanisms: 1) Fires, flames and burns (E890-899, E924-925); 2) Natural and environmental causes (E900-909); 3) Submersion, suffocation and foreign bodies (E910-915); 4) Other incidents (E926-929); 5) Poisonings (E850-869) and adverse effects of drugs (E930-949); 6) Medical misadventures (E870-876); 7) Certain types of suicide (E950-954); 8) Certain types of homicide (E960-964); 9) Legal intervention (E970-978); and 10) Injury undetermined whether unintentionally or purposely inflicted (E980-989). These E code inclusion and exclusion criteria are very similar to those used in the Montana study.

2.2 Defining "Rural"

One of the first tasks in developing our research plan was to identify the "rural" typology that we would use. The RFP we responded to did not specify the type or character of the geographically rural unit to be examined. Nor do any of the articles devoted to rural trauma care clearly define the term "rural". Waller describes some

characteristics of a rural area, but does not offer a precise definition. This problem is not unique to the study of trauma care. In July of 1989, the Congressional Office of Technology Assessment (OTA) published a staff paper entitled, "Defining 'Rural' Areas", in which it pointed that various federal agencies define rural in different manners (OTA 1989a). In November of 1989 that office issued another report entitled "Rural Emergency Services" in which different methods for defining rural were discussed, no recommendations were made regarding the use of a specific definition of the term, "rural", for studies evaluating geographic differences in trauma care (OTA 1989b). The OTA committee concluded that the typology used in studies of rural issues may have to be tailored for the study in question.

In this study, therefore, we adopted a simple, easily identifiable census-based criterion which defined a rural site as a non-Metropolitan Statistical Area (non-MSA), that is, an area defined by the Office of Management and Budget as not to meeting the definition of a MSA (see appendix I). A MSA must have a city with 50, 000 or more residents, or an urbanized area (as defined by the census bureau) with at least 50,000 people that is part of a county or counties that have at least 100,000 people. There can be significant differences between non-MSA's. For instance, a non-MSA which lies adjacent to an MSA will have access to more services than a non-MSA that is surrounded by other non-MSA's. The MSA/non-MSA taxonomy does not account for relatively uninhabited area within an MSA.

An alternative plan was considered in which the area of study would have been identified by township. In this schema, townships where 50% or more of the population is considered rural by the U.S. Census Department would constitute rural areas to be studied. Another possibility that was considered was that townships with a population of less than 5000 and 50% or more of the population considered rural by the

U.S. Census Department would constitute the rural areas to be studied. When we analyzed townships in central and southeastern Michigan using both of these definitions, we found that the townships selected for study would have varied considerably based on the manner by which they were defined. Moreover, in either case, the townships selected for study would have formed a patch-work pattern across the region that would have made it difficult to control for effects from adjacent but different non-rural areas. It also would have been extremely time consuming to identify appropriate cases and data sources, since law enforcement agencies, EMS agencies, and hospitals, would be taking care of a mix of "rural" and "non-rural" patients. We also believe that non-MSA's counties are much more comparable than "rural" townships. A non-MSA county surrounded by MSA counties and a non-MSA county unbounded by MSA counties can be more validly compared than a "rural" township surrounded by non-rural townships and a "rural" township unbounded by non-rural townships. Another factor considered was that had townships been used as our geographic unit, it would have been more difficult to compare our results to those of the Montana study.

Nevertheless, although operationally convenient, non-MSA tracts do not encompass all areas of low population density. Therefore, one should be cautious in extending any findings and conclusions based on the non-MSA data to all geographic areas of low population density.

2.3 Selection of Study Sites

The contract required that we identify 150 trauma deaths for study. To accomplish this we initially selected 21 counties in the Northern Lower Peninsula of Michigan which collectively recorded 160 trauma deaths in 1991. These counties are bounded by Lakes Michigan and Huron to the North, East and West and by non-MSA counties to the South. In general, injured patients in these counties received all their medical care resources in the study area. The combination of geographic and medical care system

characteristics resulted in a rural study area with minimum opportunity for the introduction of bias from non-rural areas.

When case accrual in the initial 21 county study area was less than anticipated, we chose to expand the study area to encompass 3 additional non-MSA counties. The only drawback to this plan was that two MSA counties now bordered the study area. As an alternative plan for lower than expected case accrual, we could have attempted to collect data from 15 counties in the Upper Peninsula (UP), all non-MSA in typology and also unbounded by MSA counties. The plan to use the UP was unworkable because of inherent logistical difficulties with regard to surveillance and data collection. The final study area therefore encompassed 24 non-MSA counties and was bordered by only two MSA counties (Fig. 1).

Preventable Trauma Deaths In Rural Michigan

Source: Michigan Information Center, Department of Management and Budget.

Figure 1

2.4 Method for Determining Preventability of Death

Michigan has a medical examiner system which is county-based, and no state medical examiner office exists. County medical examiners are required to be licensed physicians, but no further training requirements are required by the state. All accidental deaths must be investigated by a medical examiner, but performance of an autopsy is discretionary. The proportion of deaths that are autopsied and the thoroughness of the autopsy vary considerably throughout the state. In the study area the autopsy rate is approximately 20%. Due to this low autopsy rate for injury victims in the study area, the panel method was the only feasible one for determining preventability of death.

The general method we chose, therefore, to determine preventability of death, as required by the RFP, was a multidisciplinary panel review. Although guidelines for panel composition and for preventability criteria were set forth in the RFP, the actual review process itself was not stipulated. In order to maximize the likelihood of comparability between our results and those from Montana, we contacted Montana investigators to review their panel review procedures and examine their panel review documents. We found this interaction to be extremely valuable. However, because panel review conclusions may be inconsistent if the review process is completely unstructured, we modified the Montana panel method by providing information regarding optimal care and by establishing a more structured review process.

With regard to optimal care, we provided the panel with specific characteristics of the "ideal rural trauma system," including, for example, intervals which would be considered reasonable for such events as EMS notification and response. These criteria were developed by the investigators based on guidelines and recommendations from the American College of Surgeons, Committee on Trauma [ACS-COT, 1993]. Panel

members were asked to keep these criteria in mind when determining the preventability of the death.

Structured implicit review was carried out with the aid of a new review instrument developed for this study. This instrument was modified from a similar one developed for use by the RAND corporation to review the quality of care provided for elective surgical cases [Rubin HR, Kahn KL, Rubenstein LV, Sherwood MJ] [Guidelines for Structured Implicit Review of the Quality of Hospital Care for Diverse Medical and Surgical Conditions, N-3066-HCFA, RAND, 1990]. Adaptation of the structured review methodology to the study of rural preventable deaths led quickly to the development of a taxonomy for the evaluation of the trauma care system in which phases and attributes of care were explicitly identified for review and judgments requested regarding each phase and attribute, where applicable. Structured review forms directed panelists' attention to each phase of care and asked for judgments regarding appropriateness of care provided during each of those phases. This led to a more thorough and consistent review process that linked judgments regarding preventability to specific components of the trauma care system.

Panel decisions were achieved by consensus. During panel sessions, research staff recorded the nature of inappropriate care as articulated by the panel as it reached consensus. Judgments were then summarized using a list of trauma system components from which inappropriate care could be identified or improvements made. Although specific data were not collected regarding the panel members' opinions about the panel review process, it is the impression of the investigators and research staff that the panel members enjoyed the process and thought the panel methodology used was helpful.

3.0 Administrative Procedures and Tasks

3.1 Work Plan:

The following task list describes, in general, the administrative accomplishments of this project.

Task 1: Development of workplan and schedule

Task 2: Prepare an evaluation research plan

Task 3: Implementation of the workplan, schedule and evaluation research plan

Task 4: Write final report (draft and final)

4.0 Administrative Discussion

4.1 General Procedures and Tasks

In general, data acquisition was easier and more efficient than anticipated. The primary reason was that we were able to take advantage of preexisting relationships between the Michigan Trauma Coalition (MTC), and hospitals and prehospital care agencies. Also, the ability to compensate hospitals for medical records retrieved and copied saved research staff from this clerical burden. Another factor that facilitated data acquisition is Michigan Act No. 26 of Public Acts from 1980, which protects the confidentiality of research data used for studies addressing transportation issues. We were able to receive special protection under this law which also protected various agencies and institutions cooperating with us from disclosure or subpoena of all study data.

The MTC also facilitated the panel review process since almost all members of the panel, as well as research staff, already gathered once a month in Lansing for the monthly MTC meeting. Project participants agreed to share the costs of the time spent in panel review as well as travel time.

An administrative difficulty encountered while conducting this project was that one medical examiner's office provided only scanty information regarding trauma-related

deaths occurring in his jurisdiction. The cases of concern were persons who had died at the scene. Data from police or other public agencies were not helpful in supplementing the medical examiner reports, which lacked detail as to circumstances and medical findings. Consequently, we were unable to include cases from this medical examiner's jurisdiction in the study.

Because of the relative efficiency with which this project progressed, we were able to propose as a modification, a parallel study testing the reliability of our panel review for a modest cost. Panel reliability was studied by convening a second panel to review 75 cases that had reviewed by the first panel, using the same methodology. As with the first phase of our study, the second panel review went very smoothly, and we were able to complete the initially proposed study as well as the reliability study well within the time specified by NHTSA.

4.2 Individual Case Review Procedures and Tasks

Case findings was done primarily through medical examiner offices and local law enforcement agencies. Prior to beginning data collection all medical examiner offices in the study were contacted and agreed to cooperate. Research staff contacted these offices periodically throughout the study period. Also, research staff had access to the Law Enforcement Information Network (LEIN), a computerized data base into which law enforcement agencies are required to enter traffic fatality data, usually within 24 hours of occurrence. Research staff also reviewed newspaper reports within the study area to identify any cases that might have been missed. Finally, information from the Michigan Office of the State Registrar and Center for Health Statistics was obtained as a final check to determine if appropriate cases were missed.

The method of case identification differed from the Montana study. In Montana, cases were identified from death certificates filed at the state Bureau of Records and Statistics. The reasons for choosing a different method of case finding are several. First, in Michigan, it may take from six to nine months for a death certificate to be processed and entered into the state's Death Registry. Such a delay would have precluded us from completing the project within the specified timelines. Second, data on death certificates regarding the nature and/or mechanism of death may be inaccurate. Third, death certificates may have the deceased's county of residence recorded as the place of death rather than the county where the death actually occurred. Also, death certificates may not accurately record the location where the injury event took place.

To determine the scope of discrepancy that might have occurred in case finding, we contacted the State of Michigan's Center for Health Statistics in May, 1995, to compare our data to that of the state's. (Case recruitment for our study ended on December 31, 1994.) We found that the state Death Registry had 9 trauma deaths that occurred in our study area that met inclusion criteria that we had not identified. However, we identified 16 cases that were not indicated as injury deaths by the Michigan Center for Health Statistics during the study period. Overall, we were successful in identifying approximately 95% (166/175) of trauma cases meeting inclusion criteria by the method of surveillance used in this project. We think these findings support our decision as to the manner of surveillance that we chose. The characteristics of the deaths that we did not identify, and any potential bias that may occur by not including them in the analysis, will be addressed in another section of this report.

In general, all hospitals and agencies in the study area were extremely cooperative. Ultimately, they provided the information requested by our research personnel. When

data access issues did arise, a phone call and/or letter from the principal investigator succeeded in solving the problem.

Selection and recruitment of case review panel members proceeded very smoothly. Most members of the panel were also members of the MTC. Although several neurosurgeons and orthopedic surgeons were contacted and expressed interest in the study, they were unable to provide assurances that they could attend panel sessions on a regular basis. As was done in Montana, we identified a neurosurgeon and an orthopedic surgeon who could act as consultants in cases that required their expertise. Also, similar to the experience in Montana, the absence of neurosurgical and orthopedic representation on the panel presented no apparent problems. In fact, there were no cases that the panel or panel chairman thought needed input from these consultants.

Prior to convening the panel for the first review session, a training session was held for all panelists. During the training session, the study's purpose, the procedures to be followed for review, and the guidelines to be used to determine preventability were described. Three cases, supplied by investigators from the Montana study, were reviewed and discussed by panel members. During the course of the study itself, seven panel sessions were convened. As might be expected, efficiency of the review process increased with each session (Work times regarding panel member review and panel sessions are notes in appendix 2). A similar training process was used for the reliability panel.

5.0 Research Design, Data Collection Process and Analytical Procedures

5.1 Purpose: The purpose of our study was three-fold: 1) To determine the trauma preventable death rate (PDR) in rural Michigan; 2) To determine the frequency and nature of inappropriate medical care among preventable deaths; and 3) To determine the reliability of the specific panel review process used in this study.

5.2 Methods:

5.2.1 Study Design: Prospective Cohort Study

5.2.2 Subjects: All persons dying from an injury and with an ICD-9-CM E code of 800-848, 880-888, 916-923, 955-959 and 965-969 were included (Table 1). Injuries occurring from these mechanisms were excluded: 1) Fires, flames and burns (E890-899, E924-925); 2) Natural and environmental causes (E900-909); 3) Submersion, suffocation and foreign bodies (E910-915); 4) Other incidents (E926-929); 5) Poisoning (850-869) and adverse drug effects (E930-949); 6) Medical misadventures (870-876); 7) Certain types of suicide (E950-954); 8) Certain types of homicide (E960-964); 9) Legal intervention (E970-978); and 10) Injury undetermined whether unintentionally or purposely inflicted(E980-989). The death had to occur from injuries sustained within the study area and within 30 days of occurrence of those injuries.

Table 1
E code Inclusion Criteria

E code	Description
800-807	Railway incidents
810-819	Motor vehicle incidents
820-825	Motor vehicle non traffic incidents
826-829	Other road vehicle incidents
830-838	Water transport incidents
840-844	Air transport incidents
846-848	Vehicle incident, not elsewhere classifiable
880-888	Unintentional falls
916-923	Other incidents
955-959	Suicide and self-inflicted injury (excluding gunshot wounds to the head)
965-969	Homicide and injury purposely inflicted by other persons (excluding gunshot wounds to the head)

5.2.3 Time period: January 1, 1994 through December 31, 1994

5.2.4 Geographic Area: Twenty-four non-Metropolitan Statistical Area counties in the Northern Lower peninsula of Michigan (see Figure 1). The study area totaled 12,293 square miles and contained a permanent population of 484,293. The population density was 39.40 persons per square mile. Note that only two Metropolitan Statistical Area (MSA) border the study area. The injury death rate in the study area for 1992 was 64/100,000.

5.2.5 Medical Care Resources: There are 18 hospitals within the study area. Seventeen of the eighteen hospitals had physician staffing in the Emergency Department (ED) 24 hours per day. None of these hospitals are verified, by the American College of Surgeons or the State of Michigan as Level I trauma centers. Two of the hospitals provide full surgical specialty coverage, including neurosurgery. Six counties in the study area did not have 911 coverage. Eight counties have advanced life support ambulance service, 5 have limited advanced life support service and 11 counties have basic life support service. There are 149 licensed ambulances within the study area.

These include one helicopter, 26 advanced life support vehicles, 15 limited advanced life support vehicles and 107 basic life support vehicles. With few exceptions, patients injured in the study area are initially treated at and/or transferred to hospitals within the study area. The majority of injured patients are transferred by ground ambulance. Helicopter transport is used primarily for inter-hospital transfer.

5.2.6 Data Sources: Data sources included medical examiner reports, autopsy reports, police reports (including crash reports when applicable), ambulance reports and hospital records. All information sent to reviewers was stripped of personal, institutional or agency identifiers. For determining the types and severity of anatomical injury the hierarchy of data sources, from greater to lesser validity was: 1) autopsy report; 2) operative report; 3) radiology report; and 4) narrative from medical records. For determining the use of safety equipment the hierarchy was: 1) police report (crash report for MVC's); and 2) narrative from medical records. For determining the level of blood alcohol the hierarchy was: 1) state police/local police report; 2) hospital records.

5.2.7 Measurements:

Preventability of death and inappropriate care were determined using a structured implicit review process. The instrument for this review (see appendix III) was adapted from that described by Rubin et al [1990], used previously for review of elective surgery. Panelists were required to make judgements about the quality of care provided with regard to critical aspects of pre-hospital, emergency department, and hospital trauma care, such as airway management and fluid resuscitation, and to determine, in instances for which inadequate care was identified, if it contributed to the death.

The panel (Panel 1) consisted of 3 trauma surgeons, 1 emergency medicine physician, 1 critical care physician, 2 nurses experienced in trauma care, 1 prehospital care provider, and a physician medical examiner. The panel members present for any specific panel session were selected from a pool of 4 surgeons, 2 emergency physicians, 2 medical examiners/pathologists, 2 trauma nurses and 1 prehospital care provider (see appendix IV). The trauma surgeons were board certified in surgery, members of the Michigan Chapter of American College of Surgeons Trauma Committee, and routinely cared for multiply injured patients. The critical care physician was a board certified surgeon with a certificate of competency in critical care medicine. The emergency physicians on the panel were board certified in emergency medicine, members of the Michigan Chapter of the American College of Emergency Physicians Emergency Medical Services (EMS) committee, and routinely cared for multiply injured patients. The medical examiners were physicians board certified in pathology with special training in forensic medicine. The nurses on the panel had extensive clinical experience in Emergency Department and Trauma Burn Unit care and were Trauma Nurse Coordinators for urban hospitals. The prehospital care provider was licensed as a Paramedic in the State of Michigan, had over 10 years experience in prehospital care, and was also a paramedic instructor. The surgeons and emergency medicine physicians on the panel had all obtained Advanced Trauma Life Support (ATLS ^{TM}) certification from the American College of Surgeons. The panel was chaired by a trauma surgeon who was not a member of the reviewer pool. Special consultants to the panel included an orthopedic surgeon and a neurosurgeon. Panel members, the panel chairman and the consultants did not practice in the study area.

Prior to reviewing the cases all members underwent a training session to familiarize them with the implicit review process and the nature of the judgements to be made. During this session, panel members were introduced to the purpose of the study, the

review instrument and guidelines, and reviewed several sample cases from a similarly conducted study in Montana. This allowed opportunity for questions, discussion and clarification of any panel member's concerns. Prior to convening the panel, the chairman assigned each case to three panelists for intensive review. Cases were mailed two weeks prior to each meeting along with a structured review form for each case, which were to be completed independently by each panelist prior to the panel session. At the panel session, one reviewer summarized the case to open the discussion, and related his or her impressions regarding appropriateness of care and preventability of death, followed by the other two reviewers. The case was then opened for discussion. All cases being reviewed by the panel were also reviewed by the chairman. All pertinent records were available for review by panel members not assigned to the case under discussion. Panel decisions were reached by consensus. In general, discussion was terminated and a decision rendered when consensus was reached or no strong dissenting opinions were voiced by panel members.

Regarding preventability, the panel had three choices: definitely preventable (DP), possibly preventable (PP), or not preventable (NP). In formulating their decisions, the panel was asked to determine if the death could have been prevented assuming the operational conditions, exhibited in Table 2, existed. Other guidelines that were used are described in Table 3. The panel also determined the physiologic cause of death. Regarding inappropriate care, the panel was asked to determine the nature and phase (prehospital, emergency department [ED] or in-hospital) of care. When determining inappropriateness of care, panel members were instructed to consider ATLS and BTLS guidelines as well as their own knowledge and experience.

Table 2
Assumptions Regarding Ideal Rural Trauma Care

1. Patient/event identified within 5 minutes of event occurrence.
2. EMS system notified within 5 minutes of identification.
3. ALS level response within 10 minutes; EMS providers start IV's and perform endotracheal intubation.
4. Patient arrives at hospital within 45 minutes of injury event.
5. ED physician present at hospital when patient arrives.
6. Surgeon available within 30 minutes of arrival to hospital.
7. Operating room available within 60 minutes of arrival.
8. Blood bank available within 30 minutes.
9. If required, patient receives neurosurgical intervention within 2 hours.

Table 3
Guidelines for Determining Preventability

Non-Preventable:

1. Anatomic injuries considered to be non-survivable under optimum care (see Table 2)

2. Physiologic state of patient at the time of arrival of first responder may be considered, but not critical to judgement.

3. Appropriate management using Advanced Trauma Life Support (ATLS)Advanced Life Support (ALS)/Basic Trauma Life Support (BTLS) guidelines.

4. Patient had co-morbid factors which were major contributors causing death.

Possibly Preventable:

1. Anatomic injuries very severe but survivable under optimum care (see Table 2).

2. Patient generally considered unstable and responds minimally to treatment.

3. Generally appropriate ATLS/ALS/BTLS care, suspect care directly or indirectly implicated to patient demise.

Preventable:

1. Anatomic injuries considered survivable under optimum care (see Table 2).

2. Patient generally stable, if unstable patient becomes stable with treatment.
3. Evaluation and management suspect in any way.

All structured implicit review instruments were collected at the time of the panel discussion. Data on these forms included identity of reviewer, case reviewed, date of review and responses to structured review questions. Panel members were free to alter their opinions during panel discussions, but were instructed not to alter their responses on the previously completed review instrument once the case review was underway.

Injury event characteristics included date and time of injury, scene of death (out of hospital, ED or in-hospital), E code place (E849), E code cause, whether or not safety equipment was used, the source of safety information and whether or not the injury was work related. For motor vehicle crashes, the traffic vehicle deformity score (TAD) and vehicle condition (driven from scene/towed from scene) were recorded.
Patient characteristics included age, gender, race, birthdate, home FIPS, date and time of death and blood alcohol level. For subjects not pronounced dead at the scene, the initial Glasgow Coma Scale (GCS), respiratory rate and systolic blood pressure was collected from the prehospital phase and also the ED phase of care.

Injury severity was measured using the Injury Severity Score (ISS) [Baker, O'Neill, Haddon, 1974] based on the Abbreviated Injury Scale, 1985 version (AIS-85) if at least one of the following conditions were present: 1) Autopsy performed and not limited to external autopsy; 2) Patient admitted for 5 or more days; 3) CT imaging and/or surgery performed (AIS>=3); or 4) AIS 6 based on external exam (ie: decapitation). For those subjects with ISS scores, anatomical profile (AP) scores were also determined. Injury Severity Scores were calculated using TRI-CODE^{R} injury scoring software (TRI-ANALYTICS, Bel Air, MD.). Physiologic severity was measured using the Revised Trauma Score (RTS) [Champion, Sacco, Cope, 1989]. The RTS was calculated from initial prehospital vital signs and initial ED vital signs. For patients pronounced dead at the scene the prehospital RTS was designated as "0". Probability of survival (Ps) was

calculated using the TRISS methodology for patients with ISS scores [Boyd, Tolson, Cope, 1987]. For patients pronounced dead at the scene the prehospital RTS was used. For patients transported to the hospital the prehospital RTS was used.

Medical care time intervals were calculated for those subjects that were pronounced dead at the scene yet had an emergency ambulance dispatch and for patients transported to the hospital. For the former patients the following time intervals were measured: Access time of first responding unit, response time of transporting unit, response time of first transporting unit, scene time of transporting unit, transport time of transporting unit, and extrication time. For the latter patients these additional intervals were measured: minutes in radiology, minutes in a computerized axial tomography scanner (CT), and minutes in ED. Also collected was date and time of first operation.

Other data collected included the presence or absence of drugs in urine or blood. For patients not pronounced dead at the scene the total units of blood transfused, whether or not platelets/plasma were given without blood, total intensive care days, procedure codes and also procedure location were noted. For patients with ISS scores, injury N codes were collected.

The data dictionary and data collection worksheet used in this study can be found in Appendices V and VI. The variables used and definitions for variable fields are, for the most part, from Richard Cales, M.D., Hospital Trauma Register ^{R} software. With the help of Dr. Cales, we specifically modified his software to facilitate entering measurements that were specific to this study.

5.2.8 Case Finding: Prior to beginning data collection all medical examiner offices in the study were contacted and agreed to cooperate. Research staff contacted these offices

periodically throughout the study. Also, research staff had access to the LEIN system, a computerized data base into which law enforcement agencies are required to enter traffic fatality data. Research staff also reviewed the newspapers within the study area to identify any injury events and subsequent fatalities cases which may have been missed. Finally, information from the Michigan Office of Health Statistics was obtained to determine if any appropriate cases were missed.

5.2.9 Panel Reliability: The reliability of the panel methodology used to identify preventable deaths was measured by convening a second panel (Panel 2). None of the members of the second panel had participated in the first panel. A different chairman was also selected. The second panel consisted of 3 trauma surgeons, 1 emergency medicine physician, 1 nurse experienced in trauma care, 1 prehospital care provider, and a physician medical examiner (see Appendix IV). The trauma surgeons were board certified in surgery, members of the Michigan Chapter of American College of Surgeons Trauma Committee, and routinely cared for multiply injured patients. Two of the surgeons held certificates in critical care medicine. The emergency physician on the panel was board certified in emergency medicine, a member of the Michigan Chapter of the American College of Emergency Physicians Emergency Medical Services (EMS) committee, and routinely cared for multiply injured patients. The medical examiner was a physician board certified in family medicine who practiced as a public health administrator and also as a county medical examiner. The nurse on the panel had extensive clinical experience in Emergency Department and Trauma Burn Unit care and was a Trauma Nurse Coordinator for an urban hospital. The prehospital care provider was licensed as a Paramedic and also an R.N. in the State of Michigan, had over 15 years experience in prehospital care, and was also a paramedic instructor. The surgeons and emergency medicine physician on the panel had all obtained Advanced Trauma Life Support (ATLS^{TM}) certification from the American College of Surgeons. This second

panel was chaired by an emergency medicine physician who was not a member of either the first or second pool of examiners. The second panel's training process and conduction of panel sessions were similar to those of Panel 1. The second panel reviewed 18 cases determined definitely preventable or possibly preventable (DP/PP) by Panel 1 as well as 57 cases, randomly selected, that were determined non-preventable (NP) by the first panel. As before, panel members were instructed not to alter their responses on the review instrument once the case discussion was underway. The review instruments were collected at the panel session. Data on these included identity of reviewer, case reviewed, date of review and responses to structured review questions.

5.2.10 Data Entry: Data were abstracted to standardized data collection worksheets. These sheets were reviewed by the field project co-ordinator prior to data entry. Clinical data, including preventability status, were entered into a modified version of Hospital Trauma Register^{R}. Prior to final analysis these data were cleaned and reviewed for appropriateness. Data regarding the nature of inappropriate care and also panel reviewer responses were entered into an EXCEL^{R} database. These data were cleaned and reviewed for appropriateness prior to final analysis.

5.2.11 Confidentiality and Institutional Review Board Approval: The study was approved by the University of Michigan Medical Center's Institutional Review Board (IRB). Special protection of confidentiality was obtained under State of Michigan's Act No. 26 of the Public Acts of 1980.

5.2.12 Analysis: Frequency counts and percentages were determined for categorical data and means for continuous data. Confidence intervals (0.95 CI) were calculated for the PDR. Reliability between panels was measured by calculating the Kappa statistic

and its 0.95 CI for preventability status, cause of death and nature of inappropriate care. A Kappa of greater than .75 was considered excellent agreement, .60-.75 good agreement, .40-.59 fair agreement and less than 0.40 poor agreement [Fleiss, 1981]. Kappa was also calculated to determine agreement between preventability as determined by the panel method and criteria based on TRISS methodology (Ps>=0.50 indicates DP/PP death) and also ISS and AIS score (ISS <=59 with AIS in head <5 or 5 with epidural and subdural hematoma indicate P/PP death). These are criteria that have been recommended and also used by other investigators [Dykes et al., 1989a, 1989b]. McNemar's test for symmetry was also performed: a p value of <=0.05 was considered significant.

We also measured agreement between Panel 1 reviewers and the Panel 1 consensus by determining the proportion of times at least one reviewer disagreed (based on selections recorded on the review instrument) with the panel consensus. These proportions were determined for preventability status, cause of death and phase of inappropriate care.

5.3 RESULTS

5.3.1: PDR and Case Characteristics: One-hundred and sixty-six cases were identified. Nine cases did not have data sufficient for analysis. Two cases were identified after completion of the last panel session. The mean age of these 11 unreviewed cases was 38.9. In nine of these cases death had been pronounced at the scene. The other two were pronounced within 48 hours of the injury event. Seven of these deaths were from MVC's; 4 were from gun shot wounds (2 unintentional, 2 intentional).

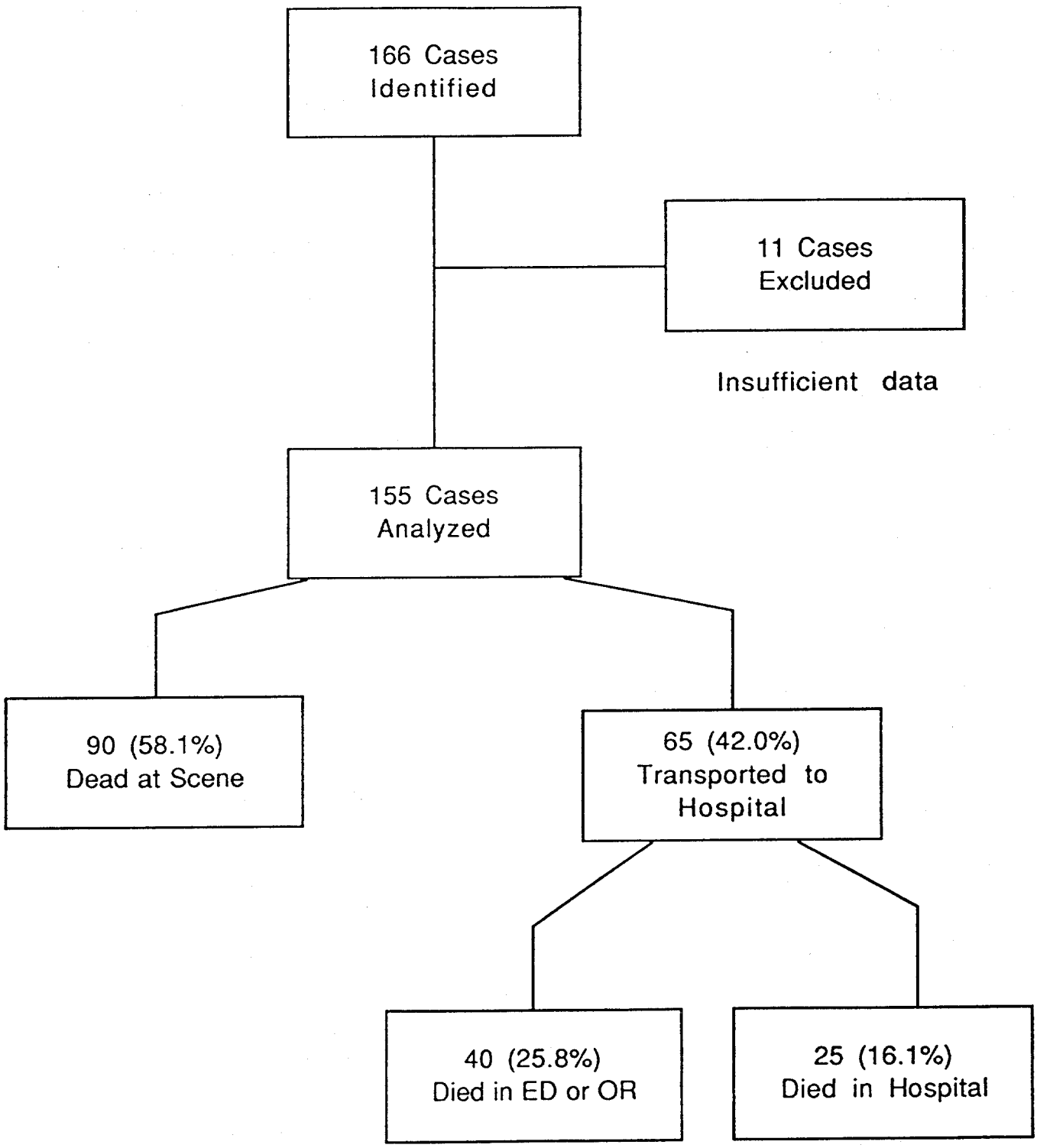

Figure 2
Study Population

One hundred fifty-five cases had sufficient data for analysis (Fig 2). The mean age for all cases was 37.4 years. There were 111 (71.60%) males and 44 (28.4%) females. Thirty-one (20%) had complete autopsies. Ninety (58.1%) were declared dead at the scene.

One hundred thirty-five deaths (87.1%) were felt to be NP; 132 of these (97.98%) occurred within 48 hours of the injury event, and included all but two scene deaths. Four deaths were judged to have been definitely preventable and sixteen possibly preventable for a combined PDR of 12.9% (Table 4a). Eighteen of the 65 deaths (27.7%) that occurred after patients were transported from the injury scene were judged to be DP/PP (Table 4b). Thirteen (65.0%) of these deaths occurred within 48 hours of injury.

Table 5 shows the age distribution of cases entered into the study. The largest number of deaths (44/155, 28%) was seen in the 35-49 age group and the 15-24 age group (37/155, 24%). The highest proportion of DP/PP deaths was seen in the 15-24 age group (7/37, 18.9%) and the 65+ age group (4/22, 18.2%).

Table 4a
Number and Percentage of Preventable Deaths (n=155)
(Percent and 0.95 CI)

Definitely Preventable	4	(2.60%: 0.39%-7.28%)
Possibly Preventable	16	(10.30%: 5.12%-17.41%)
Combined	20	(12.90%: 7.36%-20.01%)

Table 4b
Number and Percentage of Preventable Deaths
for Cases Transported to the Hospital (n=65)
(Percent and 0.95 CI)

Definitely Preventable	2	(3.08%: 0.00%-7.30%)
Possibly Preventable	16	(24.60%: 14.15%-35.09%)
Combined	18	(27.69%: 16.81%-38.57%)

Table 5
Age Characteristics by Preventability Status

	Definitely Preventable	Possibly Preventable	Not Preventable
Mean	49.75	38.00	36.97
Std. Deviation	25.50	25.15	19.48
Median	45	30	36
Range	24 - 85	1 - 83	0 - 81
Distribution			
0 - 14	0	1	13
15 - 24	1	6	30
25 - 34	0	2	19
35 - 49	2	2	40
50 - 64	0	2	15
65+	1	3	18
TOTAL	**4**	**16**	**135**

Table 6 contains the distribution of mechanisms of injury by preventability status. Overall motor vehicle related injury comprised 76.13% of cases and was the mechanism occurring most frequently. For DP/PP, motor vehicle-related deaths comprised 85% of cases. Traffic Accident Deformity (TAD) scores were obtained for 113 MVC. TAD scores ranged from 1-7 with 58.41% having a score of 7.

Table 6
Mechanism of Injury by Preventability Status

	Definitely Preventable	Possibly Preventable	Not Preventable	Total
Motor Vehicle				
Driver	1	6	60	67
Passenger	1	4	25	30
Pedestrian	0	1	9	10
Motorcycle	1	2	2	5
Other	0	1	5	6
Off-Road Vehicle	0	0	13	13
Airplane	0	0	5	5
Struck by object	0	1	8	9
Homicide	0	1	4	5
Fall	0	0	2	2
Explosion	0	0	2	2
Acc. firearm	1	0	0	1
Total	**4**	**16**	**135**	**155**

Ninety-six of 141 patients were tested for alcohol. Forty-nine (51.04%) were positive with 39 (75.59%) having levels of 100mg/dl or greater. Of the 41 subjects tested for the presence of drugs other than alcohol, 4 had positive urine drug screens.

Among motor vehicle crash victims, almost 72% of drivers or occupants were not using restraints at the time of the injury (Table 7).

Table 7
Restraint/Safety Use by Preventability Status

	Definitely Preventable	Possibly Preventable	Not Preventable	Total
Safety belt/ harness	1	2	22	**25**
Airbag/safety belt	0	0	2	**2**
Airbag	0	0	1	**1**
Helmet (motor cycle or snowmobile)	1	2	11	**14**
None	0	8	61	**69**
Unknown	1	0	9	**10**
N/A	1	4	29	**34**
Total	**4**	**16**	**135**	**155**

Death from central nervous system (CNS) injury occurred in 56 (36.13%) of all deaths and was the most frequent cause of death (Table 8). Deaths of indeterminate cause and due to hemorrhage were the second and third most frequent cause of deaths, occurring in 55 (35.48%) and 31 (20.00%) cases. Hemorrhage was the most frequent cause of DP/PP death (11/20, 55.00%), followed by CNS injury (5/20, 25.00%) cases.

Table 8
Preventability by Cause of Death

	CNS	Airway	Hemorrhage	Sepsis	Other	Indeterminate	Total
Definitely Preventable	0	0	3	1	0	0	4
Possibly Preventable	5	0	8	1	0	2	16
Non-Preventable	51	3	20	0	8	53	135
Total	56	3	31	2	8	55	155

We were able to calculate ISS scores for 88 (56.77%) cases (Table 9). Fifteen (75.00%) of the DP/PP cases had ISS scores calculated. For both DP and PP deaths, ISS scores were substantially lower than those for NP deaths. Fifty percent of DP/PP deaths had an ISS score lower than the ISS cut-off designating major trauma (ISS>= 16).

Table 9
ISS Scores

	Mean ISS	Median ISS	ISS ≥ 16	Range of ISS
Definitely Preventable (n=3)	14	13	1	13 - 16
Possibly Preventable (n = 12)	25.5	28	9	9 - 42
Not Preventable (n = 73)	51.6	54	70	5 - 75
All Cases (n = 88)	46.8	38	80	5 - 75

We were able to calculate TRISS probabilities of survival (Ps) for 86 (55.48%) cases. Seventeen (19.77%) cases had a Ps of .50 or greater (Table 10).

Table 10
Preventability Status by Ps Value

	Ps < .50	Ps ≥ .50	Total
Definitely Preventable	0	2	**2**
Possibly Preventable	4	8	**12**
Not Prev	65	7	**72**
Total	**69**	**17**	**86**

Data regarding the time interval from injury event to ambulance dispatch were obtained for 68 of 79 cases having had an emergency ambulance dispatch. The median time interval from injury event to dispatch was 4.5 minutes, with range of 0-65 minutes.

Twenty of the 65 patients transported to the ED were pronounced dead on arrival. Of the remaining 45, time data regarding the duration of time in the ED were obtained for 39 cases. Patients stayed a median time of 43 minutes in the ED with a range of 5 to 385 minutes.

Sixteen patients received blood transfusions. Data regarding the number of units transfused were obtained for 12 patients. The number of units transfused ranged from 1 to 140 with a median of 4.

Eighteen patients were sent to the radiology department for X-Rays. Data regarding time spent in the radiology department were obtained for 14 patients. The median time in the department was 48.5 minutes with a range from 15 to 90 minutes. Nineteen patients underwent computerized axial tomography (CT) scanning. Data regarding time spent in the CT scanning area were obtained on 16 cases. The median time was 34.5 minutes with a range of 5 to 97 minutes.

Forty-three episodes of inappropriate care were identified in 27 of the 155 cases studied (Table 11); 17 of these cases were DP/PP deaths. Thirty-one episodes (72%) occurred among DP/PP deaths. The majority of episodes of inappropriate care (11/12) that occurred in cases judged to be NP were identified in the pre-hospital and ED phases of care. Episodes of inappropriate care that were identified among cases judged to be DP/PP were distributed across pre-hospital (7/31), ED (12/31), and in-patient phases of care (12/31); no inappropriate care was noted for inter-facility transport for DP/PP cases. At least one episode of inappropriate care was identified in 17 of the 20 cases (85%) in which death was judged to be DP/PP. Among deaths judged to be definitely preventable, 5/7 episodes of inappropriate care were found in the in-patient phase of care.

Twenty of the episodes of inadequate care (46.51%) involved delays in evaluation or treatment, 11 episodes (25.58%) involved inappropriate airway or ventilation management, and 6 episodes (13.95%), inadequate fluid administration or blood replacement.

Overall 16 cases had at least 1 episode of inappropriate care. Seven cases had 2 episodes of inappropriate care, 3 cases had 3 episodes of inappropriate care, and 1 case had 4 episodes of inappropriate care. There were 8 cases where inappropriate care occurred more than once in a single phase of care. Sixteen episodes of inappropriate care occurred in DP/PP deaths dying from hemorrhage, with delays in treatment/evaluation and inappropriate fluid/blood management predominating. Among DP/PP deaths dying from CNS injuries, there were nine episodes of inappropriate care with inappropriate airway/ventilation management predominating.

Table 11
Inappropriate Care:
Phase and Nature by Preventability Status

	Definitely Preventable	Possibly Preventable	Not Preventable	Total
Phase and Nature				
Prehospital				
Delay in Treatment	0	4	3	7
Airway Management	0	3	3	6
(Total for Phase)				(13)
Emergency Department				
Delay in Treatment	1	1	1	3
Airway Management	0	2	1	3
Inadequate Fluid/Blood	0	5	1	6
Delay in Surgical Eval.	1	2	1	4
Inadequate Staffing	0	0	1	1
(Total for Phase)				(17)
Interfacility				
Delay in Treatment	0	0	1	1
(Total for Phase)	0	0	0	(1)
In-Hospital Phase				
Inadequate Ventilatory Mgt	0	2	0	2
Inadequate Monitoring	1	3	0	4
Inadequate Staffing	0	1	0	1
Delay in Surgical Treatment	2	1	0	3
Delay in Surgical Consult	2	0	0	2
(Total for Phase)				(12)
Total	**7**	**24**	**12**	**43**

Among cases judged to be DP/PP, 14 episodes of inappropriate care (45.16%) involved delays in evaluation or treatment, 7 (22.58%) inappropriate airway or ventilation management, and 5 (16.13%) inadequate fluid administration or blood replacement.

Two of the 3 DP/PP deaths not associated with inappropriate care were both discovered several hours after the injury event and declared dead on scene. Both died from exsanguination. The panel determined that these victims might have survived had they been discovered in a timely fashion. The remaining death expired after transfer to a second hospital. Although the panel could not identify any inappropriate care in this case they thought the patient may have been salvaged if initially taken to a hospital with Level 1 trauma center capabilities.

5.3.2 Adequacy of Surveillance: Comparing our data with that from the Michigan Office of Health Statistics five months after completion of case finding indicated that we had not identified 9 deaths occurring from injury events in our study area and meeting inclusion criteria. However, we had identified 16 cases that had not been included in the Michigan Office of Health Statistics. Thus 166/175 (95%) of trauma cases in our study area, meeting inclusion criteria, were identified by the surveillance methods used in this project.

The nine cases we did not identify had a mean age of 54. Two were dead on scene, one died in the ED and six died after admission to the hospital. The mechanism of injury for these cases included two MVC's, four falls, one bicycle incident, one incident from an animal being ridden, and one intentional gun shot wound. The cause of death listed on 7 of these death certificates was massive head injury, severe chest injury in one case, and pulmonary embolism in one case.

5.3.3 Panel Review Process and Reliability:

Panel Review Process and Reliability

Table 12 contains information regarding the participation by Panel 1 members and the sessions they attended. Table 13 shows similar information for Panel 2 members.

Table 12
Panel 1 Members/Attendance

	SESSIONS						
PANEL MEMBERS	1	2	3	4	5	6	7
Trauma Surgeon 1	X	X			X	X	
Trauma Surgeon 2	X		X	X	X	X	X
Trauma Surgeon 3	X	X	X	X	X	X	X
Intensivist	X	X	X	X	X	X	X
Medical Examiner 1	X	X					
Medical Examiner 2			X	X			X
EM Physician 1	X	X		X	X	X	X
EM Physician 2			X				
ED/Trauma Nurse 1	X	X	X	X	X	X	X
ED/Trauma Nurse 2			X	X		X	X
Prehospital Care Provider	X	X	X	X	X	X	X

Table 13
Panel 2 Members/Attendance

	SESSION	
PANEL MEMBERS	1	2
Trauma Surgeon 1		X
Trauma Surgeon 2	X	X
Intensivist	X	X
Medical Examiner	X	X
EM Physician	X	X
ED/ Trauma Nurse	X	X
Prehospital Care Provider	X	X

Seventy-five cases were analyzed for agreement. Table 14 shows agreement between the two panels with regard to preventability. For individual cases agreement was 86.60%. The Kappa statistic indicates good agreement. McNemar's test is not

significant. Table 15 shows agreement when preventability status is collapsed into two categories. Agreement was 88% with a Kappa statistic again indicating good agreement. McNemar's test was not significant.

Table 14
Inter-Panel Reliability for Preventable Death Status

	Panel 1			
Panel 2	Definitely Preventable	Possibly Preventable	Not Preventable	Total
Definitely Preventable	1 (1.33)	0 (0.00)	0 (0.00)	1 (1.33)
Possibly Preventable	1 (1.33)	9 (12.00)	2 (2.67)	12 (16.00)
Not Preventable	2 (2.67)	5 (6.67)	55 (73.33)	62 (82.67)
Total	4 (5.33)	14 (18.67)	57 (76.00)	75 (100.00)

STATISTICS FOR TABLE 14

McNemar's Test

Statistic = 4.286 DF = 3 Prob = 0.232

Kappa Coefficients

Statistic	Value	ASE	95% Confidence Bounds	
Simple Kappa	0.609	0.107	0.400	0.819

Table 15
Inter-Panel Reliability for Preventable Death Status
(P and PP deaths collapsed into 1 category)

Panel 2	Panel 1		
Frequency Percent	Preventable/ Possibly Preventable	Not Preventable	Total
Preventable/ Possibly Preventable	11 (14.67)	2 (2.67)	13 (17.33)
Not Preventable	7 (9.33)	55 (73.33)	62 (82.67)
Total	18 (24.00)	57 (76.00)	75 (100.00)

STATISTICS FOR TABLE 15

McNemar's Test

Statistic = 2.778 DF = 1 Prob = 0.096

Kappa Coefficients

Statistic	Value	ASE	95% Confidence Bounds	
Simple Kappa	0.637	0.109	0.422	0.851

Table 16 shows agreement between panels with regard to cause of death. Agreement was 69.33% with a Kappa indicating fair agreement. McNemar's test was not significant.

Panel 1 classified 7 of 75 cases as having inappropriate prehospital care; PANEL 2 classified 5 such cases. Overall agreement was 92% with a Kappa of 0.458 (0.95 CI: 0.093-0.822); the McNemar test for symmetry was not significant. Panel 1 classified 12 of 37 cases as having inappropriate ED care; Panel 2 classified 10 such cases. Overall agreement was 83.8% with a Kappa of 0.613 (0.95 CI: 0.336-0.890); the McNemar test for symmetry was not significant. Panel 1 classified 7 of 15 cases as having inappropriate in-patient care; Panel 2 found 6 such cases. Agreement was 80%; Kappa was 0.595

Table 16
Inter-Panel Reliability for Cause of Death

Panel 2	Panel 1						
	Air	CNS	Hem	Indetm.	Other	Sepsis	Total
Air	2 (2.67)	0 (0.00)	0 (0.00)	1 (1.33)	1 (1.33)	0 (0.00)	4 (5.33)
CNS	0 (0.00)	16 (21.33)	0 (0.00)	7 (9.33)	2 (2.67)	0 (0.00)	25 (33.33)
Hem	0 (0.00)	3 (4.00)	19 (25.33)	3 (4.00)	1 (1.33)	0 (0.00)	26 (34.67)
Indeterm	0 (0.00)	2 (2.67)	0 (0.00)	12 (16.00)	2 (2.67)	0 (0.00)	16 (21.33)
Other	0 (0.00)	0 (0.00)	0 (0.00)	1 (1.33)	0 (0.00)	0 (0.00)	1 (1.33)
Sepsis	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	3 (4.00)	3 (4.00)
Total	2 (2.67)	21 (28.00)	19 (25.33)	24 (32.00)	6 (8.00)	3 (4.00)	75 (100.00)

STATISTICS FOR TABLE 16

McNemar's Test

Statistic =14.111 DF = 15 Prob = 0.517

Kappa Coefficients

Statistic	Value	ASE	95% Confidence Bounds	
Simple Kappa	0.589	0.069	0.454	0.724

(0.95 CI: 0.189-1.000); the McNemar test for symmetry was not significant. **[Please note that the total number of subjects varies by phase of care analyzed because the possible phases of care in which inappropriate care may occur varies. For example, for patients being declared dead at the scene it is impossible to have inappropriate care in the ED or in-hospital phase of care.]**

Among the 155 patients reviewed by Panel 1, there was unanimous agreement between the panel's consensus on preventability and the reviewers' pre-discussion opinions as recorded on the structured review instruments for 131 (74.84%) cases; for cause of death there was unanimous agreement for 74 (47.74%) cases; and for inappropriate prehospital care there was unanimous agreement for 131 (84.52%) cases. Among the 65 cases receiving ED care, reviewers unanimously agreed with the panel consensus in 51

cases (78.46%) in which care was found to be inappropriate; for the 25 cases receiving in-hospital care, there was unanimous agreement regarding quality of care in 19 cases (76%). Panel discussion was therefore most likely to lead to changes in opinion regarding cause of death.

Comparison to Other Preventability Criteria

There were 86 cases for which the TRISS P_S score could be computed. Table 17 compares the panel judgments regarding preventability to TRISS estimated survival, assuming $P_S \geq 0.50$ signifies a preventable death. Agreement was 87.21% with a Kappa indicating fair agreement. The McNemar's test was insignificant.

Table 17
Agreement for Preventability between Panel 1 and TRISS Ps criteria

	Ps < .50	Ps >=.50	Total
Not Preventable	65 (75.58)	7 (8.14)	72 (83.72)
Definitely Preventable/ Possibly Preventable	4 (4.65)	10 (11.63)	14 (16.28)
Total	69 (80.23)	17 (19.77)	86 (100.00)

STATISTICS FOR TABLE 18 OF PREVENT BY PS

McNemar's Test
Statistic = 0.818 DF = 1 Prob = 0.366

Simple Kappa Coefficient

Statistic	Value	ASE	95% Confidence Bounds	
Kappa	0.568	0.116	0.341	0.795

There were 88 cases for which AIS and ISS scores could be computed. Table 18 compares panel judgments on preventability to estimates of preventability using ISS>59 with AIS of 5 or greater in head region without a subdural or epidural hematoma as criteria of NP. Agreement was 55.69% with Kappa indicating poor agreement. The

McNemar's test is significant, indicating asymmetry. The PDR as determined by the panel is 17.05% compared to a PDR of 54.55% determined by these ISS/AIS criteria.

Table 18
Agreement for Preventability between
Panel 1 and ISS/AIS Criteria for Preventability

	ISS > 59	ISS <=59	Total
Not Preventable	37 (42.05)	36 (40.91)	73 (82.95)
Preventable/ Possibly Preventable	3 (3.41)	12 (13.64)	15 (17.05)
Total	40 (45.45)	48 (54.55)	88 (100.00)

STATISTICS FOR TABLE 19

McNemar's Test

Statistic = 27.923 DF = 1 Prob = 0.001

Simple Kappa Coefficient

Statistic	Value	ASE	95% Confidence Bounds	
Kappa	0.164	0.072	0.022	0.305

5.4 DISCUSSION

5.4.1 General Discussion

In this study only slightly more than 10% of all deaths were preventable or possibly preventable. Hemorrhage was the most common cause of DP/PP death, CNS and indeterminate causes the most common among NP deaths. Inappropriate care was identified in all phases of care, but occurred most commonly in the ED and in-patient settings. In the prehospital phase, delay in initiating treatment was the most frequent type of inappropriate care and occurred with equal frequency in both DP/PP and NP deaths. Among cases judged DP/PP, inappropriate fluid administration or blood replacement and delay in evaluation/treatment were tied as the most frequent type of inappropriate care in the ED phase of care. In the in-hospital phase, among DP/PP

deaths, inadequate monitoring and staffing were tied with delays in evaluation and treatment as the most frequent errors. Among preventable deaths due to hemorrhage delays in evaluation and treatment were the most frequent types of inappropriate care. Among CNS injuries, inadequate airway/ventilation predominated.

In many respects our study is similar to the Montana study, the only other population based rural trauma preventable death study that has determined the PDR as well as the frequency and nature of inappropriate care. [DTNH22-90-C-05016, USDOT/NHTSA/EMS Div. 1992]. The overall PDR in that study was 17%, and for patients dying in the ED or hospital it was 30%. The phase of care most frequently associated with inappropriate care was the ED.

Notable differences, however, can be found. In our study hemorrhage was the major cause of DP/PP deaths. In Montana the major cause of death was airway compromise: no deaths were attributed to airway compromise in Michigan cases. In the Montana study airway management and inadequate chest decompression were the most frequent types of inappropriate care noted in the ED, compared to inadequate fluid and blood replacement and delays in care noted in the ED phase of care in Michigan.

These differences could be due in part to differences in the underlying mechanism of injury in the two patient groups. In Montana, almost 20% of the deaths resulted from gunshot wounds or stabbings compared to only 4% of the deaths in northern Michigan. Methodological difference may also contribute to the differences between findings in Montana and Michigan. We used a structured implicit review process modified from a previously evaluated instrument that directed attention to all phases and aspects of care, while Montana did not. It is most likely, however, that the differences between the two studies reflect actual regional differences in trauma care.

Our results are remarkably similar to those of two non-population based studies from rural Vermont. One of these studies reviewed 43 trauma deaths among patients arriving alive to the hospital [Root, Christensen, 1957]. This study found that 11 deaths (26%) were preventable and that the most frequent errors were failure to adequately treat hypovolemia and to appreciate the need for timely surgery. The other judged 22% of deaths from MVC victims arriving at the hospital to be preventable [Certo, Rogers, Pilcher, 1983]. In another study from Vermont, [Perrine, Waller, Harris, 1971], suggested that 27% of patients dying from MVC's should have survived their injuries. He noted that delay in discovery was not very often a contributing factor to unnecessary death. We found only 2 of the 20 DP/PP deaths may have survived if discovery was more timely.

Non-population based studies in non-rural or combined non-rural and rural areas prior to implementation of trauma care systems have noted preventable death rates from 21-30%, a percentage similar to the PDR for those deaths in our study that occurred in the ED or in-hospital [West, Cales, Gazzangia, 1983] [West, Trunkey, Lim, 1979].

The results from our study are in striking contrast to results from a recently published population based study in which we found a 38% PDR among rural MVC victims. We think this difference can be attributed to methodological differences. The methodological difficulties arising from determining trauma PDR, in particular the problems associated with panel review has been discussed by Salmi and others [MacKenzie, Steinwachs, Bone, 1992] [Maio, Burney, 1993] [Salmi Williams, Guibert, 1985-86] [Salmi, Williams, Waxweiler, 1990] [Wilson, McElligott, Fielding, 1992]. These investigators have focused on methodological problems regarding the panel review process or defining the appropriate populations to use when evaluating preventable

trauma mortality. None have discussed the manner by which the PDR may vary depending on the dimensions of preventability used to determine the PDR for a region. In our recently published study of preventable deaths from MVC's in Michigan, we measured only one dimension of preventability, anatomical injury severity. The only data source used was the autopsy report. Preventable death was not determined by panel review and objective criteria were used to determine preventability. No attempts were made to study the nature of medical care associated with those preventable deaths. The method we used in our current study to determine preventability considered all dimensions associated with preventability: injury severity, system performance, and individual performance. Therefore, it is not surprising that the PDR calculated in our current study is substantially different from the one determined strictly by anatomical injury severity. Another point to consider is that even if similar dimensions are used, investigators may use different indicators within a dimension. For example, the criteria we used to define an "ideal rural trauma system" (the system dimension of preventable death determination) may be different than those used by another investigator. Not surprisingly, this could be the reason for differences between findings. We think there is not any one ideal combination of dimensions or components to be used in determining preventable deaths. The combination used will depend on the research question, data sources, data quality and available resources. The rationale for the selection of the methodology in the study by Chen et al is explained in that paper [1995].

The structured implicit review that we used showed good reliability as measured by the kappa. This reliability is better than the kappa reported from other studies that used a panel review to determine preventable trauma deaths [DTNH22-90-C-05016/DOT/NHTSA/EMS Div., 1992] [MacKenzie et al, 1992] [Wilson et al, 1992]. We think this increased reliability is due to our use of the structured review instrument.

For all the structured review items that were analyzed, except for cause of death, there was unanimous agreement between reviewers and the panel's consensus at least 75% of the time. This finding supports our opinion that the structured review instrument plays a major role in effecting the final panel consensus. The low unanimity found for cause of death probably reflects the fact that few of our cases were autopsied. The reliability and easy implementation of the structured implicit review format used in this study suggests that it may a particularly valuable method and could be used by others to determine the PDR in the rural and non-rural setting.

While we would have liked to obtain overall excellent agreement we note, along with MacKenzie that research regarding agreement in other clinical decision making areas has reported Kappas of 0.2-0.3 [MacKenzie et al 1992]. Perhaps more rigorous training and standardization processes, as suggested by MacKenzie, would have increased agreement. Also, a review based on strict explicit criteria may be even more reliable than our method. We doubt that such a method will be widely useful in the near future. Exclusively using explicit criteria would require 100% autopsy rates and an understanding of the physiology of trauma and scientific substantiation of trauma care that is currently lacking.

5.4.2 Limitations:

Although based on recommendations regarding trauma systems from the ACS, the specific criteria we used to define the "ideal trauma system" have not been used elsewhere. Surveillance is also a concern. Eighty-nine percent of all potentially eligible cases were analyzed. Eleven of the 20 cases not analyzed were pronounced dead at the scene and 3 were pronounced dead on arrival at the ED. Five of these 20 deaths were the result of penetrating trauma. Although 6 of the 9 patients identified by the vital statistics data were admitted, 5 died from massive head injury. The fact that 50% of the

20 patients not analyzed were transported to the hospital, compared to 42% of the study population, suggests that excluding the former patients may slightly bias our results toward a conservative PDR. We know, however, that among excluded cases, at least 5 of the 10 patients admitted had severe brain injury and would probably be determined as non-preventable deaths, thus decreasing the magnitude of the conservative bias. If the remaining 5 of the 10 who were admitted were determined to be preventable deaths the overall PDR would be 14.3 % (25/175). Therefore, we think that including cases that were not analyzed would not significantly alter the conclusions of our study.

Another concern with our study is the number of episodes of inappropriate care. This number is relatively low when one considers categorizing these episodes by phase of care and also nature of care. Consequently, percentages calculated from these categories are very imprecise, and subsequently, interpretations and recommendations based on these calculations must be made with great caution. For example, the percentages and 0.95 CI's for the overall episodes of inappropriate care by phase of care are Prehospital: 30.23% (16.51-43.96); ED: 39.53% (24.92-54.15); and In-Hospital: 27.91% (14.50-41.31). Note the wide CI's and the fact that all intervals overlap. It's possible that differences in percentages between categories may be attributable to the imprecision of the measurement. It also must be noted that even though we were able to identify the frequency and nature of inappropriate care we did not attempt to determine the reason that inappropriate care occurred. For instance, if there was delay in surgical consultation we did not attempt to find out if the delay was due to the fact a surgeon was not on-call, the surgeon failed to respond in a timely fashion, the ED physician failed to make a timely diagnosis or a host of other possible causes.

A final concern with our study is that the composition of Panel 1 did not exactly match the composition of Panel 2 in regard to the maximum number of panelists per session. Panel 1 could have a maximum of 9 panel members and panel 2 a maximum of 7 panel members. The major differences was that Panel 2 had only 1 trauma nurse and 2 surgeons. We are unable to speculate how this difference may have biased our results. The good agreement between panels, suggests that no significant bias occurred.

5.4.3 Economic Implications:

An estimate of deaths that occurred in all non-MSA's in Michigan and the United States may be derived using the deaths determined to be definitely preventable or possibly preventable in the study area. In our study, 20 deaths were determined to be DP/PP, or 4.13/100,000 non-MSA population. The non-MSA population for the remainder of Michigan and the United States was obtained from the Michigan Information Center, Department of Management and Budget and a rate of 4.13/100,000 was applied resulting in an estimate of 66 DP/PP deaths outside the study area. Combining this with the number of DP/PP in our study area results in a total of 86 preventable deaths in the entire state. Additionally, we estimated that there were 2,084 preventable deaths in the United States. Therefore, the total number of preventable deaths in the United States including our study area is estimated at 2,170.

A report entitled, "The Economic Cost of Motor Vehicle Crashes, 1990" [Blincoe, Faigin, 1992] was used to calculate preventable death costs. The cost estimates derived by NHTSA include the following injury-related costs: Workplace productivity, household production, medical, premature funeral, emergency, insurance administration, legal and employer/workplace costs. The estimate of 1990 injury-related costs per fatality were updated to 1994 costs using the GDP deflator. Not included are the costs attributable to pain and suffering. Using the NHTSA estimates of injury-related cost, the cost per

Michigan fatality in 1994 was estimated at $760,568. The cost per fatality in the United States was $772,221. Therefore, the cost associated with the 86 preventable deaths in Michigan was $65,408,848. The cost associated with the estimated 2,084 preventable deaths in the United States was $1,609,308,500 or a total cost (including Michigan deaths) of $1,674,717,348.

Calculating the years of potential life lost (YPLL) [the age at time of death subtracted from 65; deaths among victims aged 65 years or older were assigned a YPLL of 0] for the 20 preventable deaths in the study yielded 577 YPLL, or a rate of 27.85 years per life lost. Applying this rate to the remainder of the deaths in Michigan and the United States results in a total of 60,454 YPLL.

5.4.4 Recommendations to Improve Trauma Care:

At the completion of this study, and even prior to the analysis of the data which corroborated this impression, both the panelists and the principal investigators recognized that although there exists some room for improvement in the medical care of injured persons, the real causes of "excess" rural mortality lie in the demographics of the population and characteristics of the accidents they are involved in. The number of cases in which death was found to be definitely preventable was exceptionally small: 4 of 155. One may conclude that even if optimal care had been possible in all cases, only a handful of additional lives might have been salvaged.

The relative low frequency of DP/PP deaths should not detract from the fact that they represent a significant societal burden. For the state of Michigan, we estimate the costs associated with these deaths to be over 65 million dollars and nationwide to be over 1.5 billion dollars. Despite the rural setting and absence of a state-wide trauma system,

patients were in most instances treated as if part of a larger trauma system plan, with the most seriously injured persons that survived to reach a hospital being resuscitated and transferred promptly to larger regional referral centers. Two of the four preventable deaths occurred after transfer to Level I trauma centers outside the study area. However, these observations should not be interpreted to mean that there is no room for improvement. It should also be emphasized that our study only analyzed a mortality measure, the PDR. There may be many changes in the delivery of trauma care in the study area that would improve non-mortality patient outcomes, but have little impact on mortality. In regard to preventable mortality, the results from our study show that efforts to decrease the PDR should primarily focus on the ED and in-hospital phase of care. The nature of inappropriate care noted in our study suggests that the manner in which to decrease the PDR is through better planning and training, not through the use of more technology. In particular, hospitals need to ensure that procedures are in place to facilitate timely surgical consultation and also availability of blood products. Training should focus on the appropriate treatment of hemorrhagic shock and airway/ventilation management. The exact manner as to how these changes are to be implemented in Michigan, will be a topic for discussion by the Michigan Trauma Coalition.

If the rural trauma mortality is to be substantially reduced, efforts must be directed toward prevention as much as to continued improvements within the acute care system.

5.4.5 Recommendations for future research:

Studies should be done to evaluate some of our basic assumptions regarding the panel review process. We assume that by decreasing the frequency of inappropriate care associated with preventable deaths, we will decrease the frequency of preventable

deaths. Implicit in this thinking is our belief that the inappropriate care we identify significantly impacts on patient outcome. One way by which to empirically validate this speculation would be to compare preventable deaths with survivors. If after controlling for age and injury severity, we find that inappropriate care has a stronger association with preventable deaths than survivors, our speculation would be supported. Such a study could be conducted retrospectively using case-control methodology.

Reporting the nature and frequency of inappropriate care is helpful but does not provide sufficient information for determining the reason for that inappropriate care occurring. Future studies should be conducted which provide detail analysis of inappropriate care. The results from these studies would be extremely valuable for implementing strategies to decrease inappropriate care.

The process used to determine preventable trauma deaths is an extremely complex one. The theoretical framework from which it is based must be defined more extensively. Such a framework would be useful in the planning of future evaluations as well as interpreting current and future research findings. These theories can then be tested using both pre-existing as well as newly collected data.

Studies should be conducted to improve consistency of panel-derived data. Further development and refinement of the structured implicit review instrument used in this study is warranted. Also, we think the methodology from our study can easily be used to conduct population based preventable death studies in non-rural areas. Such studies would enable us to estimate the magnitude and characteristic of preventable trauma mortality in non-rural areas which would facilitate intervention strategies and priorities.

Efforts directed at determining the reasons for geographic differences in the PDR could ultimately lead to more efficient trauma care.

Future analyses of preventable trauma deaths should also focus on non-medical measures that would have prevent mortality. Panels would not only evaluate secondary prevention but primary prevention as well.

A study similar to ours is currently being conducted in North Carolina. With its completion there will be three completed population based preventable rural trauma mortality studies. Because of the relatively low incidence of preventable deaths and inappropriate care, meta-analysis of these studies may be helpful in discovering relationships not evident in any particular one of the studies.

Prospective studies to determine the impact of interventions in rural areas is the most scientifically sound manner by which to determine effectiveness. However, the large geographic areas and low incidence of rural trauma preventable mortality makes this a formidable task. For example, to detect a decrease of 5% in the PDR, with appropriate power (alpha = 0.05, B =.20), assuming a base PDR of 12%, would require a total of almost 1100 deaths. To accomplish this study would require co-ordinating data collection throughout the rural areas of several states. Such studies can only be conducted if substantial funding is available. Without such funding effectiveness studies may be limited to retrospective cohort or case-control studies, studies using historical controls, or quasi-experimental before/after studies.

Finally, perfect data will never be obtained, but even imperfect data can point the way toward aspects of system care which are most likely to lead to improvement if

continuous quality improvement model is adopted. How to build this into the system is an important question for future studies.

5.5 CONCLUSION

Only a relatively small percentage of rural trauma fatalities could have been saved by more appropriate or timely medical care. Current efforts to reduce this percentage should be primarily directed towards the ED and in-patient phases of care with particular attention to delays in treatment and evaluation of hemorrhage management and patient monitoring. Results from our study also suggest that changes in acute rural trauma care will only marginally reduce the overall rural trauma death rate. Further studies should evaluate how resources need to be distributed between primary injury prevention and acute medical care delivery systems in order to most efficiently decrease rural trauma mortality.

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Appendix I

Definition of Metropolitan Statistical Area (MSA) and non-Metropolitan Statistical Area (non-MSA)

Source: U.S. Bureau of the Census,
Statistical Abstarct of the United States: 1994
(11th edition), Washington D.C., 1994

Metropolitan Areas: Concepts, Components, and Population

Statistics for metropolitan areas (MA's) shown in the *Statistical Abstract* represent areas designated by the U.S. Office of Management and Budget (OMB) as metropolitan statistical areas (MSA's), consolidated metropolitan statistical areas (CMSA's), and primary metropolitan statistical areas (PMSA's).

The general concept of an MA is that of a core area containing a large population nucleus, together with adjacent communities having a high degree of economic and social integration with that core. Currently defined MA's are based on application of 1990 standards (which appeared in the *Federal Register* on March 30, 1990) to 1990 decennial census data. These MA definitions were announced by OMB effective June 30, 1993.

In this appendix, tables A, B, and C present historical summary information for MA's and nonmetropolitan areas as defined on certain dates. Table E presents geographic components and latest populations for each MSA, CMSA, and PMSA. As of the June 1993 OMB announcement, there were 250 MSA's, and 18 CMSA's comprising 73 PMSA's in the United States. (In addition, there were 3 MSA's, 1 CMSA, and 3 PMSA's in Puerto Rico; MA's in Puerto Rico do not appear in these tables.) Table D presents definitions and data for New England county metropolitan areas (NECMA's), the county-based alternative metropolitan areas for the city- and town-based MSA's and CMSA's of the six New England States.

Standard definitions of metropolitan areas were first issued in 1949 by the then Bureau of the Budget (predecessor of OMB), under the designation "standard metropolitan area" (SMA). The term was changed to "standard metropolitan statistical area" (SMSA) in 1959, and to "metropolitan statistical area" (MSA) in 1983. The current collective term "metropolitan area" (MA) became effective in 1990. OMB has been responsible for the official metropolitan areas since they were first defined, except for the period 1977 to 1981, when they were the responsibility of the Office of Federal Statistical Policy and Standards, Department of Commerce.

The standards for defining metropolitan areas were modified in 1958, 1971, 1975, 1980, and 1990.

Defining MSA's, CMSA's, and PMSA's. The current standards provide that each MSA must include at least: (a) One city with 50,000 or more inhabitants, or (b) A Census Bureau-defined urbanized area (of at least 50,000 inhabitants) and a total metropolitan population of at least 100,000 (75,000 in New England).

Under the standards the county (or counties) that contains the largest city becomes the central county (counties), along with any adjacent counties that have at least 50 percent of their population in the urbanized area surrounding the largest city. Additional "outlying counties" are included in the MSA if they meet specified requirements of commuting to the central counties and other selected requirements of metropolitan character (such as population density and percent urban). In New England, the MSA's are defined in terms of cities and towns rather than counties.

An area that meets these requirements for recognition as an MSA and also has a population of one million or more may be recognized as a CMSA if: 1) separate component areas can be identified within the entire area by meeting statistical criteria specified in the standards, and 2) local opinion indicates there is support for the component areas. If recognized, the component areas are designated PMSA's, and the entire area becomes a CMSA. (PMSA's, like the CMSA's that contain them, are composed of individual or groups of counties outside New England, and cities and towns within New England.) If no PMSA's are recognized, the entire area is designated as an MSA.

The largest city in each MSA/CMSA is designated a "central city," and additional cities qualify if specified requirements are met concerning population size and commuting patterns. The title of each MSA consists of the names of up to three of its central cities and the name of each State into which the MSA extends. However, a central city with less than one-third the population of the area's largest city is not included in an MSA title unless local opinion desires its inclusion. Titles of PMSA's also typically are based on central city names but in certain cases consist of county names. Generally, titles of CMSA's are based on the names of their component PMSA's.

A 1990 census list, CPH-L-145, showing 1990 and 1980 populations for current MA's and their component counties or New England subcounty areas is available through the Statistical Information Office, Population Division, (301) 763-5002. A 1990 census Supplementary Report, 1990 CPH-S-1-1, *Metropolitan Areas as Defined by the Office of Management and Budget, June 30, 1993,* contains extensive population and housing statistics for the current MA's and is available from the U.S. Government Printing Office (GPO) (stock number 003-024-08738-3). Also available from the GPO is the Census Bureau's wall map for the 1993 MA's (stock number 003-024-08740-5).

Appendix II
Time Requirements for Individual Reviews and Panel Sessions

Panel Sessions
Panel I session times totaled 15 hours

Individual Reviewers:
Average time for review was 30-45 minutes for a definitely preventable or possibly preventable deaths and 5-10 minutes for non-preventable deaths.

Appendix III
Instruments for Structured Review

Pre-Hospital Care/ Emergency Medical Services

Inter-Facility Transfer Care

Second Hospital Emergency Department Care

Care Provided at Second Hospital After Transfer

Outcome Summary Sheet

Case Numer ___ ___ ___ Reviewer ID ___ ___ ___

Michigan Preventable Death Study
Quality Review Form

PRE-HOSPITAL CARE/EMERGENCY MEDICAL SERVICES

1. How would you rate the quality of each of the following components of pre-hospital care?

	Very Poor	Poor	Medium	Good	Excellent
a. Accessibility of EMS	___	___	___	___	___
b. Assessment by EMTs of nature and severity of patient's injuries?	___	___	___	___	___
c. EMTs initial treatment/ stabilization of patient?	___	___	___	___	___
d. Time to provide initial care?	___	___	___	___	___
e. Time to arrival at hospital?	___	___	___	___	___

2. Did any of the following occur during care provided by EMS providers that resulted from insufficient skills or training or from inadequate care? Did this affect outcome? (check one of first four columns and last column)

	Occurred definitely result of poor treatment	Occurred probably result of poor treatment	Occurred but not result of poor treatment	Did not occur	Did not affect outcome
a. Airway obstruction	___	___	___	___	___
b. Inadequate ventilation	___	___	___	___	___
c. Hypotension/ shock	___	___	___	___	___
d. Excessive blood loss?	___	___	___	___	___
e. Neurologic deterioration/injury?	___	___	___	___	___
f. Inadequate or delayed treatment	___	___	___	___	___
g. Death	___	___	___	___	___

3. Considering the patient's care in the Emergency Department, on average, do you believe the amount used of each of these kinds of treatments or tests was:

	Definitely Too little	Probably Too Little	About Right	Probably Too Much	Definitely Too Much
a. Airway management	___	___	___	___	___
b. Ventilatory management	___	___	___	___	___
c. Fluid resuscitation	___	___	___	___	___
d. Blood transfusion	___	___	___	___	___
e. Chest and other plain xrays	___	___	___	___	___
f. Chest tubes	___	___	___	___	___
g. Diagnostic peritoneal lavage	___	___	___	___	___
h. CT scans, special xrays	___	___	___	___	___
i. Invasive monitoring (i.e., arterial line, CVP, etc.)	___	___	___	___	___

4. How would you rate the quality of each of the following components of Emergency Department care?

	Very Poor	Poor	Medium	Good	Excellent
a. Notification of ED Physician	___	___	___	___	___
b. Evaluation by ED Physician	___	___	___	___	___
c. Notification of Consultant(s):					
General Surgeon (n/a ___)	___	___	___	___	___
Orthopedic Surgeon (n/a ___)	___	___	___	___	___
Neurosurgeon (n/a ___)	___	___	___	___	___
d. Evaluation by Consultants:					
General Surgeon (n/a ___)	___	___	___	___	___
Orthopedic Surgeon (n/a ___)	___	___	___	___	___
Neurosurgeon (n/a ___)	___	___	___	___	___
e. Recognition of injuries	___	___	___	___	___
f. Identify/Stabilize Fractures	___	___	___	___	___
g. Stabilization/Monitoring of Pt	___	___	___	___	___

5. Did the patient suffer any adverse consequences resulting from acts or omissions by Emergency Department providers that you would classify as mistakes?

	Occurred definitely result of mistakes	Occurred probably result of mistake(s)	Occurred not result of mistake(s)	Did not occur or not applicable
a. Airway obstruction	___	___	___	___
b. Respiratory insufficiency	___	___	___	___
c. Hypotension	___	___	___	___
d. Excessive blood loss	___	___	___	___
e Neurologic injury	___	___	___	___
f. Delay in Treatment	___	___	___	___
g. Death	___	___	___	___

If patient was transferred to a second hospital, please complete Inter-facility Transfer Care and Second Hospital ED review forms.

6. Considering the patient's care in the Hospital, on average, do you believe the amount used of each of these kinds of tests or treatments was:

	Definitely Too little	Probably Too Little	About Right	Probably Too Much	Definitely Too Much
a. Intensive Care Unit	___	___	___	___	___
b. Intubation and mechanical ventilation	___	___	___	___	___
c. Arterial blood gases	___	___	___	___	___
d. Invasive hemodynamic monitoring (e.g. pulmonary artery catheter)	___	___	___	___	___
e. Transfusions	___	___	___	___	___
f. Plain x-rays	___	___	___	___	___
g. Special xrays, CT angio, etc	___	___	___	___	___
h. Consultations	___	___	___	___	___

7. a. Did the patient have surgery during the hospital stay?

Yes _____ No _____

b. Do you believe the patient should have had surgery?

Definitely not _____ Probably not _____ Not sure _____

Probably yes _____ Definitely yes _____

8. If the patient had surgery, how would you rate:

	Very Poor	Poor	Medium	Good	Excellent
a. the type of surgery chosen	___	___	___	___	___
b. the timing of surgery	___	___	___	___	___
c. stabilization prior to surgery	___	___	___	___	___
d. technical quality of the surgery	___	___	___	___	___
e. postoperative surveillance and management	___	___	___	___	___

9. Did the patient suffer any adverse consequences resulting from acts or omissions by hospital providers that you would classify as mistakes?

	Occurred definitely result of mistakes	Occurred probably result of mistake(s)	Occurred not result of mistake(s)	Did not occur or not applicable
a. Airway obstruction	___	___	___	___
b. Respiratory insufficiency	___	___	___	___
c. Hypotension	___	___	___	___
d. Excessive blood loss	___	___	___	___
e Neurologic injury	___	___	___	___
f. Delay in Treatment	___	___	___	___
g. Single or multiple organ failure	___	___	___	___
h. Sepsis	___	___	___	___
i. Death	___	___	___	___

Case Numer ___ ___ ___ Reviewer ID ___ ___ ___

Michigan Preventable Death Study
Quality Review Form

INTER-FACILITY TRANSFER CARE (IFTC)

1. Inter-facility transfer was carried out by: Air Medical Service ___ Ground EMS ___

2. Level of Care during inter-facility transfer: RN ___ Adv EMT ___ EMT ___

3. How would you rate the quality of each of the following components of inter-facility care?

(leave blank if unknown)	Very Poor	Poor	Medium	Good	Excellent
a. Accessibility of service	___	___	___	___	___
b. Response time?	___	___	___	___	___
c. Assessment of nature and severity of patient's injuries?	___	___	___	___	___
d. Pre-transfer stabilization of patient?	___	___	___	___	___
e. Management during transfer?	___	___	___	___	___
f. Time to destination hospital?	___	___	___	___	___

4. Did the patient suffer any adverse consequences from acts or omissions by inter-facility transfer providers that resulted from insufficient levels of skill or training or that you would classify as mistakes?

	Occurred definitely result of mistakes	Occurred probably result of mistake(s)	Occurred not result of mistake(s)	Did not occur or not applicable
a. Airway obstruction	___	___	___	___
b. Inadequate ventilation	___	___	___	___
c. Hypotension/ Shock	___	___	___	___
d. Excessive blood loss?	___	___	___	___
e. Neurologic injury?	___	___	___	___
f. Inadequate or delayed treatment	___	___	___	___
g. Death	___	___	___	___

Case Numer ___ ___ ___ Reviewer ID ___ ___ ___

Michigan Preventable Death Study
Quality Review Form

SECOND HOSPITAL EMERGENCY DEPARTMENT CARE

1. If patient was transferred to a second hospital, was decision to transfer made according to pre-existing protocol or on *ad hoc* basis? protocol ___ ad hoc ___ don't know ___

2. Was second hospital a designated or verified trauma center? Yes ___ No ___

3. If yes, what level? Level I ___ Level II ___ Level III ___

4. With regard to the patient's care in the second hospital Emergency Department, on average, do you believe the amount used of each of these kinds of treatments or tests was:

	Definitely Too little	Probably Too Little	About Right	Probably Too Much	Definitely Too Much
Airway management	___	___	___	___	___
Ventilatory management	___	___	___	___	___
Fluid resuscitation	___	___	___	___	___
Blood transfusion	___	___	___	___	___
Chest and other plain xrays	___	___	___	___	___
Chest tube(s)	___	___	___	___	___
Diagnostic peritoneal lavage	___	___	___	___	___
CT scans, special xrays	___	___	___	___	___
Invasive monitoring (i.e., arterial line, CVP, etc.)	___	___	___	___	___

5. How would you rate the quality of each of the following components of Emergency Department care at second hospital?

	Very Poor	Poor	Medium	Good	Excellent
a. Notification of ED Physician	___	___	___	___	___
b. Evaluation by ED Physician	___	___	___	___	___

5. Quality of ED care. cont.	Very Poor	Poor	Medium	Good	Excellent
c. Notification of Consultant(s):					
General Surgeon (n/a ___)	___	___	___	___	___
Orthopedic Surgeon (n/a ___)	___	___	___	___	___
Neurosurgeon (n/a ___)	___	___	___	___	___
d. Evaluation by Consultants:					
General Surgeon (n/a ___)	___	___	___	___	___
Orthopedic Surgeon (n/a ___)	___	___	___	___	___
Neurosurgeon (n/a ___)	___	___	___	___	___
e. Recognition of injuries	___	___	___	___	___
f. Identify/Stabilize Fractures	___	___	___	___	___
g. Stabilization/Monitoring of Pt	___	___	___	___	___

6. Did the patient suffer any adverse consequences resulting from acts or omissions by providers at second hospital Emergency Department that you would classify as mistakes?

	Occurred definitely result of mistakes	Occurred probably result of mistake(s)	Occurred not result of mistake(s)	Did not occur or not applicable
a. Airway obstruction	___	___	___	___
b. Respiratory insufficiency	___	___	___	___
c. Hypotension	___	___	___	___
d. Excessive blood loss	___	___	___	___
e Neurologic injury	___	___	___	___
f. Delay in Treatment	___	___	___	___
g. Death	___	___	___	___

Case Numer ___ ___ ___ Reviewer ID ___ ___ ___

Michigan Preventable Death Study
Quality Review Form

CARE PROVIDED AT SECOND HOSPITAL AFTER TRANSFER

1. Considering the patient's care in the Hospital, on average, do you believe the amount used of each of these kinds of tests or treatments was:

	Definitely Too little	Probably Too Little	About Right	Probably Too Much	Definitely Too Much
a. Intensive Care Unit	___	___	___	___	___
b. Intubation and mechanical ventilation	___	___	___	___	___
c. Arterial blood gases	___	___	___	___	___
d. Invasive hemodynamic monitoring (e.g. pulmonary artery catheter)	___	___	___	___	___
e. Transfusions	___	___	___	___	___
f. Plain x-rays	___	___	___	___	___
g. Special xrays, CT angio, etc	___	___	___	___	___
h. Consultations	___	___	___	___	___

2. a. Did the patient have surgery during the hospital stay?

Yes _____ No _____

b. Do you believe the patient should have had surgery?

Definitely not ____ Probably not ____ Not sure ____

Probably yes ____ Definitely yes ____

3. If the patient had surgery, how would you rate:

	Very Poor	Poor	Medium	Good	Excellent
a. the type of surgery chosen	___	___	___	___	___
b. the timing of surgery	___	___	___	___	___
c. stabilization prior to surgery	___	___	___	___	___
d. technical quality of the surgery	___	___	___	___	___
e. postoperative surveillance and management	___	___	___	___	___

4. Did the patient suffer any adverse consequences resulting from acts or omissions by hospital providers that you would classify as mistakes?

	Occurred definitely result of mistakes	Occurred probably result of mistake(s)	Occurred not result of mistake(s)	Did not occur or not applicable
a. Airway obstruction	___	___	___	___
b. Respiratory insufficiency	___	___	___	___
c. Hypotension	___	___	___	___
d. Excessive blood loss	___	___	___	___
e Neurologic injury	___	___	___	___
f. Delay in Treatment	___	___	___	___
g. Single or multiple organ failure	___	___	___	___
h. Sepsis	___	___	___	___
i. Death	___	___	___	___

reb 5/26/94

Case Numer ___ ___ ___ Reviewer ID ___ ___ ___

Michigan Preventible Death Study
Quality Review Form

OUTCOME SUMMARY SHEET

1. How would you characterize the patient's outcome, given the patient's injuries and circumstances?

As expected ____

Worse than expected ____

Much worse than expected ____

2. From what you know about the patient's injuries, after reviewing the entire record, what do you believe would have been this patient's chance of survival assuming excellent care throughout his course.

O% _____ < 25% ___ <50% ___ >50% ___ >75% ___

3. From what you know about the patients injuries and care, what was the principal cause of death?

CNS injury ____

Airway ____

Hemorrhage/ shock ____

Sepsis/Organ Failure ____

Other ____

Indeterminate ____

4. Was the patient's death preventable (given optimal care, considering circumstances)?

Definitely preventable ____

Possibly preventable* ____

Definitely not preventable ____

* if possibly preventible, what is likelihood that death was preventible ?

0-1% ___ 2-10% ___ 11-25% ___ 26-49% ___

5. Was inappropriate/inadequate care a significant contributing factor to the patient's death?

Yes _____ No ____

5a. During what phase of care did inappropriate/inadequate care occur:

Prehospital	____
ED	____
First Hospital	____
Interfacility	____
Second ED	____
Second Hospital	____

6. Would improvements in trauma system (rather than in performance of individuals) have improved this patient's chances of survival?

Yes _____ No ____

7. If yes, which aspects of trauma system? (check all that apply)

a. Patient identification ____

b. EMS System notification ____

c. Timeliness/ level of pre-hospital response/ care ____

d. Initial delivery to appropriate level hospital (if available) (e.g., bypass protocol) ____

e. Initial assessment/ stabilization in ED ____

f. Timeliness of surgical evaluation/ care ____

g. Timeliness of transfer for definitive care (e.g., transfer protocol) ____

h. Accessibility of Trauma Center care? ____

i. Treatment protocols at hospital providing definitive care? ____

j. Other system improvement _____

8. How much time did you spend on this review? (Minutes) ___ ___

Appendix IV
Panel Review Members

PANEL #1 MEMBERS

Ben L. Bachulis, MD, FACS *Board certified in Surgery, Member MI-ACS, COT*
Michael J. Caplan, MD *Board certified in Pathology, special training in Forensic Medicine*
John J. Fath, MD, FACS *Board certified in Surgery, Member of MI-ACS, COT, Certificate in Critical Care Medicine*
Dale R. Feldhouser, EMT-P *Licensed Paramedic, BTLS Instructor, Over 10yrs experience in prehospital care*
Paul W. Gikas, MD *Board certified in Pathology, Special training in Forensic Medicine*
Frederick M. Ilgenfritz, MD, FACS *Board certified in Surgery, Member of MI-ACS, COT,*
Jon R. Krohmer, MD, FACEP *Board certified in Emergency Medicine, Member of MI-ACEP, EMS*
Yvonne Lozen, RN, MSN, CCRN *9 yrs experience in ED and trauma care, Trauma nurse coordinator for urban trauma center, Trauma nursing core course (TNCC) Instructor*
Judy Mikhail, RN, MSN, CCRN, CEN, EMT *Over 10yrs experience in ED and trauma care, Trauma nurse coordinator for urban trauma center, Trauma nursing core course (TNCC) Instructor*
Robert A. Swor, DO, FACEP *Board certified in Emergency Medicine, Member of MI-ACEP, EMS*

PANEL #2 MEMBERS

PANEL MEMBERS
Roxie M. Albrecht, MD, FACS *Board certified in Surgery, Member of MI-ACS, COT*
William Fales, MD *Board certified in Emergency Medicine, Member of MI-ACEP, EMS*
Deb Jurewicz, RN, EMT-P, I/C *Licensed Paramedic, BTLS Instructor, 15 yrs experience in prehospital care*
Connie Mattice, RN, MSN, CCRN *Over 10 yrs experience in ED and trauma care, Trauma nurse coordinator for urban trauma center, Certified in Trauma Nursing Core course*
Dean T. Smith, MD, FACS *Board certified in Surgery, Member of MI-ACS, COT*
Marvin Smitherman, MD, FACS *Board certified in Surgery, Member of MI-ACS, COT, Certificate in Critical Care Medicine*
Richard, M. Tooker, MD Board certified in Family Practice *Public Health Administrator/Medical Examiner*

5/26/95

Appendix V
Data Dictionary

Rural Trauma Mortality Study
Data Dictionary

1. REGISTER NUMBER [REGISTERNO]
   [00002]

2. INJURY DATE [INJDATE]
   [Unk]
   [06/13/94]

3. INJURY TIME [INJTIME]
   [Unk]
   [2315]

4. AGE [AGE]
   [Unk]
   [Fet] Fetus
   [000] Under 1 year
   [019]

5. SEX [SEX]
   [Unk]
   [M]
   [F]

6. RACE [RACE]
   [1] White, non-Hispanic
   [2] Black, non-Hispanic
   [3] White Hispanic
   [4] Black Hispanic
   [5] American Indian
   [6] Pacific Islander
   [7] Asian
   [8] Other

7. BIRTH [BIRTHDATE]
   [Unk]
   [01/20/1960]

8. SCENE FIPS CODE [FIPSSCENE]
   FIPS code for state and county of patient injury scene
   [Unk]
   [41051]

9. HOME FIPS CODE [FIPSHOME]
   FIPS code for state and county of patient's home
   [Unk]
   [41005]

10. E-CODE PLACE [ECODE849]
    [NA]
    [E849.x]

11. E-CODE CAUSE [ECODE]
[Unk]
[E810.0]

12. SAFETY EQUIPMENT [SAFETYEQPT]
[NA]
[Unk]
[1] None or inappropriate use
[2] Safety belt/harness
[3] Air bag and safety belt
[4] Air bag only
[5] Infant/child seat
[6] Helmet
[7] Padding/protective clothing
[8] Other

13. WORK-RELATED [WORKRELATE]
[Unk]
[No]
[Yes]

14. GLASCOW COMA SCALE TOTAL [PHGCSTOTAL] Range = 003-015
[NA]
[Unk]
[013]

15. RESPIRATORY RATE [PHRESPRATE] Range = 000-150
[NA]
[Unk]
[032]

16. SYSTOLIC PRESSURE [PHSYSTOLIC] Range = 000-300
[NA]
[Unk]
[000]
[088]

17. TRAUMA SCORE, REGULAR [PHTSREG] Range = 1-16

18. VEHICLE NUMBER, PRE-HOSPITAL [VEHNOPH]

19. CARIDOPULMONARY ARREST TIME [PHARREST]
[NA]
[Unk]
[No]
[2327]
[????] Prehospital cardiopulmonary arrest time unknown

20. MINUTES FOR RESPONSE OF TRANSPORTING UNIT [RESPONMINS]
Minutes between transporting unit dispatch and injury scene arrival
[NA]
[Unk]
[020]

21. MINUTES AT SCENE OF TRANSPORTING UNIT [SCENEMINS]
Minutes between transporting unit arrival and patient departure
[NA]
[Unk]
[015]

22. MINUTES FOR TRANSPORT TO HOSPITAL [TRANSPMINS]
Minutes between transporting unit scene departure and hospital arrival
[NA]
[Unk]
[025]

23. EMERGENCY DEPARTMENT DATE [EDDATE]

24. EMERGENCY DEPARTMENT TIME [EDTIME]
Time admitted to E.D. of hospital of record (where patient died)

25. GLASCOW COMA SCALE TOTAL [EDGCSTOT] Range = 003-015
[NA]
[Unk]
[013]

26. RESPIRATORY RATE [EDRESPRATE] Range = 000-150
[NA]
[Unk]
[032]

27. RESPIRATORY STATUS [EDRESPSTAT]
[NA]
[Unk]
[1] Ventilated but not intubated
[2] Intubated but not ventilated
[3] Ventilated and intubated

28. SYSTOLIC PRESSURE [EDSYSTOLIC] Range = 000-300
[NA]
[Unk]
[000]
[088]

29. TRAUMA SCORE, REGULAR [EDTSREG] Range = 1-16

30. TRAUMA SCORE, REVISED [EDTSREV] Range = 0-8

31. BLOOD ALCOHOL [EDALCOHOL] Range = 000-999
[NA] Not tested
[Unk] Result unknown
[120]

32. DRUG SCREEN [EDDRUGS]
[NA] Not tested
[Unk] Result unknown
[No] Test performed and result negative
[Yes] One or more listed results positive

33. PLATELETS/PLASMA WITHOUT BLOOD [PLATEFFP]
[NA]
[Unk]
[No] 8 or more units of blood prior
[Yes] Platelets/plasma administered during first 24 hours with 7 or less units of bloods prior

34. TOTAL UNITS OF BLOOD TRANSFUSED [TOTALBLOOD]
[NA]
[Unk]
[000] Blood ordered but unused
[012] Blood transfused and total units known

35. RADIOLOGY MINUTES [RADMINS]
[NA]
[Unk]
[33] Total minutes in radiology

36. CT MINUTES [CTMINS]
[NA]
[Unk]
[13] Total minutes in computed tomography scan

37. DISPOSITION FROM DEPARTMENT [EDDISPOSTN]
[1] Seen in ED and discharged home
[2] Seen in ED and left against medical advice
[3] Seen in ED and admitted to observation unit
[4] Seen in ED and admitted to floor
[5] Seen in ED and admitted to stepdown unit
[6] Seen in ED and admitted to intensive care
[7] Seen in ED and admitted to operating room
[8] Seen in ED and transferred to another facility
[9] Seen in ED and expired, including DOA

38. MINUTES IN DEPARTMENT [EDMINS]
[NA]
[Unk]
[137] Total minutes in emergency department

39. TOTAL INTENSIVE CARE DAYS [ICUDAYS]
[NA]
[Unk]
[000] Admitted to ICU but for less than one day
[007]

40. DATE OF FIRST OPERATION [OPDATE]
[NA]
[Unk]
[06/13/94]

41. TIME OF FIRST OPERATION [OPTIME]
[NA]
[Unk]
[0613]

42. INJURY CODE 1 [NCODE1]
43. INJURY CODE 2 [NCODE2]
44. INJURY CODE 3 [NCODE3]
45. INJURY CODE 4 [NCODE4]
46. INJURY CODE 5 [NCODE5]
47. INJURY CODE 6 [NCODE6]
48. INJURY CODE 7 [NCODE7]
49. INJURY CODE 8 [NCODE8]
50. INJURY CODE 9 [NCODE9]
51. INJURY CODE 10 [NCODE10]

52. INJURY SEVERITY SCORE, 1985 [INJSEVSCOR] Range = 000-075

53. SURVIVAL PROBABILITY [SURVPROB]

54. PROCEDURE CODE 1 [PCODE1]
55. PROCEDURE CODE 2 [PCODE2]
56. PROCEDURE CODE 3 [PCODE3]
57. PROCEDURE CODE 4 [PCODE4]
58. PROCEDURE CODE 5 [PCODE5]
59. PROCEDURE CODE 6 [PCODE6]
60. PROCEDURE CODE 7 [PCODE7]
61. PROCEDURE CODE 8 [PCODE8]
62. PROCEDURE CODE 9 [PCODE9]
63. PROCEDURE CODE 10 [PCODE10]

64. PROCEDURE LOCATION 1 - PROCEDURE LOCATION 10 [PLOC]
    [N] Not Applicable
    [U] Unknown
    [E] Emergency Dept.
    [F] Floor
    [I] Intensive Care
    [O] Other
    [P] Prehospital
    [T] Transferring Hospital
    [1] First Surgery

USER DEFINED FIELDS

1. REGISTER NUMBER [REGISTERNO]
   [00002]

2. PREVENTABILITY [PREVENT]
   As determined by physician panel
   [YES] - Death was preventable
   [NO] - Death was not preventable
   [MAYBE] - Death was possibly preventable

3. ACCESS MINUTES OF THE TRANSPORTING UNIT [ACCESSMINS]
   Minutes between injury occurrence and dispatch of transporting unit

4. VEHICLE NUMBER OF FIRST RESPONDING UNIT [VEHNOPH1]

5. ACCESS MINUTES OF THE FIRST RESPONDING UNIT [ACCESSMIN1]
   Minutes between injury occurrence and dispatch of first unit

6. RESPONSE MINUTES OF THE FIRST RESPONDING UNIT [RESPONMIN1]
   Minutes between first responder dispatch and injury scene arrival

7. SCENE MINUTES OF THE FIRST RESPONDING UNIT [SCENEMIN1]
   Minutes between first responder arrival and patient departure

8. TRANSPORT MINUTES OF THE FIRST RESPONDING UNIT [TRANSPMIN1]
   Minutes between first unit scene departure and hospital arrival

9. EXTRICATION MINUTES [EXTRICMINS]
   Number of minutes to extricate patient (as indicated on prehospital report)

10. INJURY SEVERITY SCORE, 1990 [AIS90ISS] Range = 000-075

11. G-SCORE [GSCORE]
    Sum values of the AP components multiplied by the following coefficients:
    $G = 4.0801 - 0.4914\ (A) - 0.2066\ (B) - 0.0161\ (B^2) - 0.0351\ (C^2)$

12. ANATOMIC PROFILE A SCORE [APASCORE]
    Square AIS scores for head/brain, spinal cord; sum and take the square root

13. ANATOMIC PROFILE B SCORE [APBSCORE]
    Square AIS scores for thoracic region; sum and take the square root

14. ANATOMIC PROFILE C SCORE [APCSCORE]
    Square AIS scores for abdomen/pelvis; sum and take the sqaure root

15. ANATOMIC PROFILE D SCORE [APDSCORE]
    Square AIS scores for face/other superficial injuries; sum and take the square root

16. ANATOMIC PROFILE COMPONENT SCORE [APCOMP]
    The sum of A, B, C and D component values

17. PROBABILITY OF SURVIVAL, ASCOT [ASCOTPS]
    G score + revised trauma score

18. SOURCE OF SAFETY INFORMATION [SAFETYSRC]
[NA]
[Unk]
[1] Crash report
[2] Prehospital report
[3] ED/Medical record

19. VEHICLE DEFORMITY [TADSCORE]
For motor vehicle crashes, level of vehicle deformity indicated on crash report (1 = lowest, 7 = highest)
[NA]
[Unk]
[1] [2] [3] [4] [5] [6] [7]

20. VEHICLE CONDITION [VEHCOND]
For motor vehicle crashes, condition of vehicle indicated on crash report
[NA]
[Unk]
[1] Towed from scene
[2] Driven from scene

21. DATE OF DEATH [DATEDTH]
[06/13/1994]

22. TIME OF DEATH [DCTIME]
[Unk]
[1440]

23. CAUSE OF DEATH [CAUSEDTH]
As determined by the physician panel
[Airway]
[CNS]
[Hemorrhage]
[Sepsis]
[Other]
[Indeterminate]

24. PLACE OF DEATH [PLACEDTH]
[Dead on scene]
[Died in emergency department]
[Died in hospital]

Appendix VI
Data Collection Work Sheet

Panel Date_____

RURAL TRAUMA MORTALITY STUDY
ABSTRACT

DEMOGRAPHY

REGISTERNO			__/__/__/__/__
INJDATE		Unk	__/__-__/__-__/__
INJTIME		Unk	__/__/__/__
AGE		Unk	__/__/__
SEX		Unk	__
RACE		Unk	__
BIRTHDATE		Unk	__/__-__/__-__/__/__/__
FIPSSCENE		Unk	__/__/__/__/__
FIPSHOME		Unk	__/__/__/__/__
ECODE849	NA		E/__/__/__.__
ECODE		Unk	E/__/__/__.__
SAFETYEQPT	NA	Unk	__
WORKRELATE		Unk	No Yes

PREHOSPITAL

PHGCSTOTAL	NA	Unk	__/__/__
PHRESPRATE	NA	Unk	__/__/__
PHSYSTOLIC	NA	Unk	__/__/__
VEHNOPH	NA	Unk	__/__/__/__/__
PHARREST	NA	Unk	No __/__/__/__
RESPONMINS	NA	Unk	__/__/__
SCENEMINS	NA	Unk	__/__/__
TRANSPMINS	NA	Unk	__/__/__

EMERGENCY

EDDATE			__/__-__/__-__/__
EDTIME	NA	Unk	__/__/__/__
EDGCSTOT	NA	Unk	__/__/__
EDRESPRATE	NA	Unk	__/__/__
EDRESPSTAT	NA	Unk	__
EDSYSTOLIC	NA	Unk	__/__/__
EDTSREG	NA	Unk	__/__/__
EDALCOHOL	NA	Unk	__/__/__
EDDRUGS	NA	Unk	No Yes
PLATEFFP	NA	Unk	No Yes
TOTALBLOOD	NA	Unk	__/__/__
RADMINS	NA	Unk	__/__/__
CTMINS	NA	Unk	__/__/__
EDDISPOSTN	NA		__
EDMINS	NA	Unk	__/__/__
ICUDAYS	NA	Unk	__/__/__

INPATIENT/INJURIES

OPDATE	NA	Unk	__/__-__/__-__/__	
OPTIME	NA	Unk	__/__/__/__	
NCODE1			__/__/__.__/__	
AIS901			__/__	*AIS851* __/__
ISSBOD901			__	*ISSBOD851* __/__
APCOMPCAT			__	
NCODE2			__/__/__.__/__	
AIS902			__/__	*AIS852* __/__
ISSBOD902			__	*ISSBOD852* __/__
APCOMPCAT			__	

Items in Italics For Information Only

NCODE3			__/__/__.__/__											
AIS903			__/__	*AIS853*	__/__									
ISSBOD903			__	*ISSBOD853*	__/__									
APCOMPCAT			__											
NCODE4			__/__/__.__/__											
AIS904			__/__	*AIS854*	__/__									
ISSBOD904			__	*ISSBOD854*	__/__									
APCOMPCAT			__											
NCODE5			__/__/__.__/__											
AIS905			__/__	*AIS855*	__/__									
ISSBOD905			__	*ISSBOD855*	__/__									
APCOMPCAT			__											
NCODE6			__/__/__.__/__											
AIS906			__/__	*AIS856*	__/__									
ISSBOD906			__	*ISSBOD856*	__/__									
APCOMPCAT			__											
NCODE7			__/__/__.__/__											
AIS907			__/__	*AIS857*	__/__									
ISSBOD907			__	*ISSBOD857*	__/__									
APCOMPCAT			__											
NCODE8			__/__/__.__/__											
AIS908			__/__	*AIS858*	__/__									
ISSBOD908			__	*ISSBOD858*	__/__									
APCOMPCAT			__											
NCODE9			__/__/__.__/__											
AIS909			__/__	*AIS859*	__/__									
ISSBOD909			__	*ISSBOD859*	__/__									
APCOMPCAT			__											
NCODE10			__/__/__.__/__											
AIS9010			__/__	*AIS8510*	__/__									
ISSBOD9010			__	*ISSBOD8510*	__/__									
APCOMPCAT			__											
INJSEVSCOR		Unk	__/__/__											
PCODE1	NA		__/__.__/__	LOC	N	U	E	F	I	O	P	T	1	
PCODE2	NA		__/__.__/__	LOC	N	U	E	F	I	O	P	T	1	
PCODE3	NA		__/__.__/__	LOC	N	U	E	F	I	O	P	T	1	
PCODE4	NA		__/__.__/__	LOC	N	U	E	F	I	O	P	T	1	
PCODE5	NA		__/__.__/__	LOC	N	U	E	F	I	O	P	T	1	

PCODE6	NA	__/__.__/__	LOC	N	U	E	F	I	O	P	T	1
PCODE7	NA	__/__.__/__	LOC	N	U	E	F	I	O	P	T	1
PCODE8	NA	__/__.__/__	LOC	N	U	E	F	I	O	P	T	1
PCODE9	NA	__/__.__/__	LOC	N	U	E	F	I	O	P	T	1
PCODE10	NA	__/__.__/__	LOC	N	U	E	F	I	O	P	T	1

USER DEFINED FIELDS

PREVENT	Yes	No	May	
ACCESSMINS	NA	Unk	__/__/__	
VEHNOPH1	NA	Unk	__/__/__/__/__	
ACCESSMIN1	NA	Unk	__/__/__	
RESPONMIN1	NA	Unk	__/__/__	
SCENEMIN1	NA	Unk	__/__/__	
TRANSPMIN1	NA	Unk	__/__/__	
EXTRICMINS	NA	Unk	__/__/__	
AIS90ISS		Unk	__/__/__	Injury Severity Score (1990)
GSCORE		Unk	__.__/__/__/__	
APaSCORE		Unk	__.__/__	
APbSCORE		Unk	__.__/__	
APcSCORE		Unk	__.__/__	
APdSCORE		Unk	__.__/__	
APCOMP		Unk	__/__.__/__	
ASCOTPS		Unk	__.__/__	
SAFETYSRC	NA	Unk	__	
TADSCORE	NA	Unk	__	
VEHCOND	NA	Unk	__	
DATEDTH		Unk	__/__-__/__-__/__	
DCTIME		Unk	__/__/__/__	
CAUSEDTH			_____	
PLACEDTH			_____	